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No. 19

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MATERIAL PROCESSING EXPERIMENTS ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 1 Jul 82 p 2

[Article by B. Konovalov, IZVESTIYA special correspondent reported from Flight Control Center: "The Facets of Cooperation"]

[Excerpt] "Turn on computer memory prior to beginning the 'Diffuziya' [Diffusion] experiment. I remind you that the capsule is being inserted into a furnance heated to a temperature of 905 degrees Centigrade. Be careful when you extract the charger. After the furnace goes into operation its temperature is about 100 degrees." A Flight Control Center operator is instructing the international crew as the men begin the next series of technological experiments in orbit.

The joint Soviet-French technological experiments "Kalibrovka" [Calibration], "Diffuziya" and "Likvatsiya" [Liquation] are now being conducted in the "Kristall" [Crystal] apparatus with "Magma-F" furnace, transported to Salyut-7 by the Progress-13 cargo ship. The production of valuable materials in orbit is one of the most promising trends in the development of cosmonautics. It may lead eventually to the establishment of orbital shops and factories for production of materials which are very difficult or simply impossible to create under earth conditions. But the path to these space plants of the future is a difficult one and hides much that is unexpected. Extensive and comprehensive research is required.

The aim of the "Kalibrovka" experiment is to obtain data for building a mathematical model for thermal processes that take place in the electrical heating furnace under the conditions of microgravitation which actually exist on board the station. The fact is that true weightlessness exists only in the overall center of mass of the space vehicle complex Salyut-7 - Soyuz T-5 - Soyuz T-6 when it is travelling in so-called gravitational stabilization, when the common axis of the space complex is directed towards the earth's center. Micromovements and vibrations occur in the same location where the "Kristall" apparatus is positioned although the cosmonauts are specially prohibited from using the "runner's treadmill" and in general from swaying their orbital home when the technological experiments are being conducted.

The "Kalibrovka" experiment was developed by the National Center for Nuclear Research in Grenoble and the Institute for Space Research of the USSR Academy of Sciences. It entails detailed measurements of thermal fields in the furnace for various operating conditions while simultaneously recording the accelerations occuring at the orbital station.

The two other joint experiments, "Diffuziya" and "Likvatsiya," are still more basic in nature--they comprise research into the very essence of the processes that take place during orbital production of one substance or another is capsules using test specimens developed by French experts.

"The orbital research we are currently conducting is part of the overall science of the study of materials," states Claude Potar, the Grenoble specialist at Flight Control Center responsible for the set of technological experiments. "And it therefore offers great primary scientific value. In addition, we are hoping that conditions in space will enable us to obtain materials of very high quality, possessing, for example, a very fine structure or other physical properties. They can serve as the basis for producing such valuable specimens under earth conditions. Eventually orbital organization of production may turn out to be economically feasible as well for subsequent utilization of the obtained materials in our earth technology."

"We are happy with the progress being achieved in the experiments conducted by Jean-Loup Chretien and his colleagues. I consider the cooperation with Soviet experts in developing the experiments as quite beneficial for us and for the overall development of a young new science, the study of materials in space."

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EXPERIMENTS WITH ELECTRIC FURNACE ON 'SALYUT-7'

Moscow PRAVDA in Russian 29 Jun 82 p 3

[Article by A. Pokrovskiy, PRAVDA special correspondent, reporting from Flight Control Center: "Everything's Working Fine"]

[Excerpt] The medical research was conducted first, as has already been mentioned. Then it came time to carry out a series of experiments in another sphere--production technology.

This is a regularly used term in reports on orbital station experiments. It is quite naturally very tempting to take advantage of the vacuum and weightlessness freely available in space--which no amount of money can buy on earth--for the manufacture of materials inaccessible on our planet. We are referring primarily to the small-scale production of, let us say, semiconductors or exotic alloys which at present are required in small quantities. However, one can already imagine entire orbital shops effecting production output in the future that would be unattainable or too expensive on earth. This is why scientists are continuing their efforts in this direction so persistently.

Those organizing the production technology experiments state that each new development progresses through three major stages--discovery, study of its potential and implementation. While we may say that the first and last of these stages are quite interesting, the second stage comprises painstaking, none too glamorous--monotonous, if you will--experimentation. This is precisely what our Salyut-7 cosmonauts are currently engaged in.

But French participation in these experiments has attached to them a distinctive hue. Soviet experts fashioned a unique addition to the "Kristall" [Crystal] unit--the "Magma-F" electric furnace. In it can be placed ampules--metal cases "lined" with quartz from within--of greater dimensions than before. They are about 20 mm in diameter and 200 mm long. But our fellow scientists in the metallurgy department of the National Center for Nuclear Research in Grenoble have complemented it with electronic devices for measuring and recording temperature and a number of other parameters at 14 different points on the electric furnace itself and on the ampules placed in it.

"This is important," states J.-P. Lepage, responsible for the technological portion of the experiment, "both for understanding the response of materials located in the ampule, and for subsequently building thermal and mathematical models of the furnace.

The on-board computer memory carefully records all the data obtained, then transmits it to earth for subsequent analysis.

The cosmonauts began their work with furnace calibration. First they heated it to 600 degrees, then regulated it so that the experimental ampule was heated up uniformly. Then the temperature was raised to 900 degrees. All of this took about 11 hours. Only then was it time to conduct the "Diffuziya" [Diffusion] experiment (measuring the speed at which lead and copper polycrystals dissolve in liquid copper) and the "Likvatsiya" [Liquation] experiment (studying the potential for producing new alloys under conditions of weightlessness from metals immiscible on earth). In other words, the search continues for ways to take advantage of conditions in space for furthering scientific and technological progress on earth.

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BIOMEDICAL AND TECHNICAL EXPERIMENTS ON 'SALYUT-7'

Moscow PRAVDA in Russian 26 May 82 p 3

[Article by A. Pokrovskiy, special correspondent: "An Institute in Orbit"]

[Text] "I was in space 9 years ago, but the sensation remains as if it had only been yesterday."

That is what Valentin Lebedev says about his feelings. Many cosmonauts have mentioned that the body more or less "remembers" its sojourn in weightlessness and then, on the next flight, adapts to space conditions more rapidly. On the other hand, Anatoliy Berezovoy, who is a new recruit in space, did not experience any serious difficulties during the adaptation period.

"He went through it pretty easily," say the friendly "El'brus" crew members.

However, this situation is a new one not only for the commander, but also for the flight engineer. We would like to begin with the fact that this is the first time either of them has worked in an orbital station. And an orbital station is noticeably different from a "Soyuz" ship as far as the systems--primarily the scientific equipment--is involved. The designers also did not neglect the opportunity to improve some of the instruments on board the "Salyut-7." For instance, the medical examinations of A. Berezovoy and V. Lebedev are now conducted with the new "Aelita" equipment instead of the old "Polinom" apparatus.

"It is more convenient for the cosmonauts and the examination takes less time," say the chief of the USSR Ministry of Health's Space Biology and Medicine Adminstration, Ye. Shchul'zhenko, and the Deputy Flight Director for Medicine, Doctor of Medical Sciences A. Yegorov. "This is essentially a compact cabinet for functional diagnostics. At this stage of residence in space, we have set ourselves the goal of not only studying the activities of various human organs and systems in space, but also are attempting to make an integrated approach to understanding the functioning of the body under these conditions. In addition to this, the problem of discovering the individual special features of the crew members and the hidden reserves of the human body has been formulated more clearly."

We talked with the specialists in space medicine for a long time. First of all, of course, we wanted to find out whether or not they had found any limits to the duration of flights into space after studying the results of "marathon"--for half a year or more--flights.

"No irreversible changes have been detected in any cosmonaut's body," was the answer. "And from this viewpoint we are definitely optimistic. For the final answer, however, it is necessary to know whether or not there are any changes on the cellular level and in the genetic mechanism. In that area, however, the cosmonauts are not very suitable objects for experiments. That, in particular, is why experiments with plants in the 'Oazis' devices are continuing."

However, although the geneticists have not yet found genetic changes in plants, neither classic arabidopsis nor onions, nor peas wish to bear fruit on board space stations, even though they develop normally initially.

"Consequently," the specialists conclude, "the problem is apparently one of defects in the experimental equipment."

And it has also been improved, by changing the watering system and introducting aeration of the roots. Even in this situation Berezovoy and Lebedev must deal with modified equipment.

Yesterday they received yet another "Oazis" unit that was delivered into orbit by the "Progress-13" cargo ship, so the "El'brus" members' "biological" worries have been enlarged. These are not the only ones, however. As is well known, "Salyut-7" is a multipurpose station. Even now this flying scientific institute is receiving more equipment and the scope of the research is being expanded. Correspondingly, Berezovoy and Lebedev are faced with having to act as broad-profile scientific workers: technologists, because "Progress-13" delivered a "Kristall" technological installation; astronomers, since they now have at their disposal an instrument for determining the brightness of stars that was manufactured by Czechoslovakian scientists; physicists, since they have received equipment for visual investigations of the Earth's upper atmosphere.

"True," remarks Candidate of Technical Scientists L. Gorshkov, "first they have to work as riggers for a while. 'Progress-13' delivered tons of cargo, including fuel, water, food and clothing. The boys begged us to send them flying boots, because in weightlessness one's feet get cold. They will have quite a bit of trouble with the scientific equipment, because the cargo was not a standard one and special fastenings had to be fixed up for it on the 'Progress.'

"I would like to mention," continues Leonid Alekseyevich, "that this was the first rendezvous of a 'freighter' with 'Salyut-7.' It was very important for us to see how the ship and the station would behave. However, the automatic equipment that carried out the docking performed flawlessly. A. Berezovoy and V. Lebedev, who were also participating in this operation for the first time, interacted excellently with the ground services."

Judging by everything, the increasing amount of work is not bothering the "El'brus" crew.

"It is even pleasant," they reported from orbit, "to see how our scientific equipment has been reinforced."

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'BRASLET', 'POZA' AND 'EKHOGRAFIYA' EXPERIMENTS ON 'SALYUT-7'

Moscow PRAVDA in Russian 28 Jun 82 p 3

[Article by V. Gubarev, PRAVDA special correspondent reported from Flight Control Center: "The Equilibrium Point"]

[Excerpt] The elixir of youth has finally been found! It turns out there is a way to get rid of the burden of age, to gain strength and health, to become more energetic.

"I made this discovery quite recently," says Patrick Baudry smiling. "I was 33 when I arrived at Zvezdnyy Gorodok [Star City]. I began training with Jean-Loup and suddenly we discovered we'd grown younger. Today I am not 35, but 32..." A cosmonaut is obliged to be in excellent shape and must have a thorough knowledge of his own body--not only to be able to endure lift-off acceleration, weightlessness and the extra g-force upon landing, but also in order to accomplish a huge number of medical science experiments.

I asked Patrick Baudry, backup for the first French cosmonaut, to comment on how the international crew's work on the Soviet orbital complex began. He agreed.

Vladimir Dzhanibekov, Aleksandr Ivanchenkov and Jean-Loup Chretien began their first working day on board Salyut-7 with "Braslet" [Bracelet].

Blood rushes to the head during the first hours of space flight--earth's gravitation is absent in orbit. Sometimes your head swells up and you get painful sensations. The cuffs reduce the flow of blood to the upper half of the body, somewhat imitating earth's gravity.

"It's comfortable when you use 'Braslet'," Patrick Baudry comments. "Jean-Loup and I had to 'walk' upside-down many times in training for the flight. There's a special training apparatus at Zvezdnyy Gorodok which uses 'Braslet'. You tighten the cuffs and, although you're hanging upside-down for quite some time, you don't feel any rush of blood..." From space Jean-Loup confirmed that he was experiencing the same effect he had experienced during training for this experiment on earth.

In about an hour the cosmonauts loosened the cuffs and removed "Braslet" from their legs. But as soon as they felt once again that their head was "getting heavy," medical experts recommended that they go back to using the device. The crew conducted the "Braslet" experiment five times in a 24-hour period.

"Poza" [Posture] was the first Soviet-French experiment to be conducted by the international crew.

It might seem from the sidelines that Jean-Loup Chretien isn't engaged in any very serious activity--all the while he is making attempts to raise his arm quickly. As it turns out, under conditions of weightlessness this stroke of the arm we are so accustomed to require caution and constant checking. On earth we don't give very much thought to the fact that not only the arm muscles participate in this movement, but many others as well, including those of the legs. It happens that quickly raising an arm in space changes a person's posture (whence the name of the experiment)--the cosmonaut begins to rotate! In order to maintain equilibrium it is necessary to follow one's arm movement with his eyes. As the program provides for, Jean-Loup Chretien closes his eyes, draws them aside and...against his will he "floats" in weightlessness. Valentin Lebedev is recording his every movement on film.

"The instrumentation was built in France," Patrick Baudry comments, "and registers bio-electrical activity of the muscles that maintain body stability. This experiment is being conducted in space for the first time and is quite comprehensive. It began on earth, is continuing at the orbital station, and will be completed after the crew's return. We were first introduced to the instrumentation in Paris, where so-called 'background studies' were twice conducted. Then at Baykonur, three days prior to launch, still another study took place. Scientists in France and the Soviet Union will obtain new data on man's condition in outer space which will aid in the understanding of the mechanisms by which the central nervous system functions."

The daily routine is packed and, frankly, specialists at Flight Control Center doubted that everything would be fully accomplished--the crew had still not completely learned how to cope with weightlessness.

"If you don't manage to finish 'Poza' by 1720 hours, then don't hurry--we can postpone "Ekhografiya' [Echo Sounder Recording] until the next fly-over," an operator advised delicately.

"Look--we've already started on it!" Dzhanibekov replies.

"We're feeling great, says Chretien, "and we're going to try to get everything done we were supposed to."

"The 'Ekhografiya' experiment is devoted to conducting research on the influence of space flight factors on the blood flow distribution in major blood vessels of the human body and to studying the contracting function of the myocardium during the critical adaptation period..." Thus begins a description of the experiment in the cosmonaut's manual.

"Scientists are using the ultrasonic echo finder method for the heart and main blood vessels," Baudry comments. "We use 'Ekhografiya' in our clinics. But of course, of 50 million Frenchmen, only one is in outer space and it is very interesting to compare earth and space data. 'Ekhografiya' demands caution, composure and thoroughness. Doctors noticed many times that Jean-Loup was

better than they in using this apparatus to conduct the research during training. Conscientious preparation on the ground has helped him complete this experiment too in such a successful manner.

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FURTHER COMMENTARY ON BIOMEDICAL STUDIES BY SOYUZ T-6 CREW

Moscow IZVESTIYA in Russian 29 Jun 82 p 2

[Article by B. Konovalov, IZVESTIYA special correspondent reporting from Flight Control Center: "A 'Bracelet' For the Cosmonaut"]

[Text] "The doctors are going to be amazed when they see what wonders medical science is concocting with man," the voice of Valentin Lebedev is heard during one of the communications sessions.

The "Pamir Group" is conducting the "Poza" [posture] experiment on board Salyut-7 and Lebedev is recording their actions on film. Weightlessness is apparently making its jovial corrections--the cosmonauts are all laughing together.

In the "Poza" experiment a cosmonaut "glued over" with sensing elements stands up on a special platform and executes a simple movement, one we're all accustomed to--he must quickly raise his arm, as if taking aim with a pistol. While he is doing this the platform is free to move by virtue of his movement as well as when specially pushed by one of his comrades.

This experiment began long before the flight, is currently underway in orbit, and will be continued after the cosmonauts return to earth so that medical experts can conduct comparison and analysis.

The experiment was developed by the department of neurosensory physiology at the work physiology laboratory of the National Center for Scientific Research in Paris and by the Institute for Problems of Information Transmission of the USSR Academy of Sciences. Its purpose is to study interactions between the cosmonaut's sensory organs and his motor system during conditions of weightlessness.

We usually don't think too much about the complicated work our organism accomplishes in order to execute any, even the most simple movement. Yet the central nervous system, which controls all of our movements and coordinates the functioning of our muscles, must instantaneously process the data received from the many sensing elements of the various sensory systems--vestibular, optical, muscle/joint and dermal. On earth, the signals from all these systems mutually complement one another, enable man to adequately effect spatial orientation without any special effort, and allow him to maintain the required posture, i.e., a certain body position.

Under space flight conditions, in the absence of the force of gravity, information transmitted by the receptors of many body systems to the central nervous system differs sharply from that transmitted on earth--the usual coordination and interaction between them disappears. In space it is chiefly the eyes that give information as to the body's position. In the "Poza" experiment, therefore, the cosmonaut's monitored movement will be performed over the entire flight under conditions of ordinary vision, limited field of vision, and with eyes completely closed. Experimental signals from the sensory elements are received at an electronic block unit and travel from there to a digital magnetic recorder. Scientists will be able to use this to trace changes in biological activity of the basic muscles that take part in maintaining posture stability and in effecting body dislocation when the hand is thrust forward in weightlessness.

Presenting the group of French authors of the "Poza" experiment at Flight Direction Center, Zhil' Kleman told journalists he was satisfied with progress being made in the research. It must be said that weightlessness necessitated making slight corrections to the plans. Thus, the cosmonauts spent four hours instead of the alloted two to completing the entire cycle of research in the first experiment conducted. This is interesting in itself.

"We would very much like the Soviet cosmonauts to continue the "Poza" experiment even after the Soviet-French expedition has ended, and obtain results for a flight of extended duration," Zhil' Kleman said.

It should be noted that medical and biological experiments very likely occupy the central position in the program of the first Soviet-French manned space flight. And this is understandable--for the first time France is able to conduct experiments in the sphere of space medicine and biology with her own representative participating.

"Jean-Loup Chretien is feeling fine," Doctor of Medical Sciences A. D. Yegorov, Deputy Flight Director for Medical Science told journalists. "As with Dzhanibekov and Ivanchenkov, his process of adaptation to weightlessness is proceeding normally. His work efficiency is high."

In order to eliminate the unfavorable effect of blood rushing to the head which all cosmonauts experience during their first days in orbit, the "Pamir Group" is conducting the preventive "Braslet" [bracelet] experiment developed by the Institute for Medical and Biological Problems of the USSR Ministry of Health. At the start of the day members of the "Pamir Group" don fixative belts and apply pinching cuffs to their thighs over their flight suits made of elastic, resilient material. Depending on how the cosmonaut feels, straps are used to tighten the cuffs for 30-60 minutes. This retains the blood in the lower half of the body, imitating the influence of the force of gravity and allowing the cosmonaut to feel better. Up to five of these cycles take place over the course of a 24-hour period. In no way does this interfere with the conduct of the other experiments.

"Remember, we have to measure Jean-Loup Chretien's arterial blood pressure," the voice of a Flight Direction Center operator is heard as "Ekhografiya" [Echo Sounder Recording], one of the most interesting experiments of the joint flight program is begun. This experiment was developed by the Biophysics Laboratory of the Tours Institute of Medicine, the Radioactive and Ultrasonic Medicine Service of the Tours Uni-

versity Hospital and the Institute for Medical and Biological Problems of the USSR Ministry of Health. It utilizes the ultrasonic echo-finder method and the so-called "Doppler effect" (related to the motion process) to study the influence of space flight factors on blood flow distribution in the major blood vessels of the human organism and on heart behavior.

"Echo finding will enable us to make precise measurements of heart volume, for example," Rene Bost told journalists as he presented most of the French experiments at Flight Direction Center. "The study of blood flow in certain blood vessels and organs presents a great deal of interest. Blood circulation in the veins, for example, is still a subject inadequately studied. A comparison of results obtained under conditions of weightlessness and on earth will better enable us to learn how blood flows through the veins to the heart. The main purpose of the medical and biological program of the joint flight is fundamental research that will allow us to better understand how the circulatory and vestibular systems function in weightlessness. Right from birth man lives under conditions of gravitation, and this is a very significant factor of our existence. But up until now very little study has been made of the influence of gravity simply because it is impossible to avoid it. Only an excursion into outer space can afford us this opportunity. Such research is therefore important to the overall study of human physiology. It will allow us to take a look at many questions from a new perspective. We are pleased that we now have the opportunity to conduct experiments in space. The Soviet specialists we are currently working with are very highly qualified, and we are very happy to take part in this mutually beneficial cooperative effort."

While the primary crew is carrying out experiments in orbit, the backup crew is not only assisting in their work, but is shouldering responsibility for the first press onslaught as well. A large press contingent from many countries reporting from Moscow on the Soviet-French space flight assembled Sunday at the USSR Ministry of Foreign Affairs press center, and met with Leonid Kizim, Vladimir Solov'yev and Patrick Baudry.

"The 'Pamir Group' is doing spendid work," they told the journalists. "They are actually over-fulfilling the program of scientific experiments. Jean-Loup Chretien is feeling quite fine in weightlessness, and a spirit of good will reigns at the space station."

Aleksey Leonov, Deputy Director of the Center for Cosmonaut Training confirmed the opinion of the stand-in crew--"All crew members get a grade of 'excellent'."

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'TSITOS-2' AND 'BIOBLOK-3' EXPERIMENTS

Moscow PRAVDA in Russian 1 Jul 82 p 6

[Article by A. Pokrovskiy, PRAVDA special correspondent, reporting from Flight Control Center: "The Peak of the Expedition"]

[Text] "The past three days have been quite intense," Deputy Flight Director V. Kravets stated as he pointed to the highly concentrated activity schedule for cosmonauts A. Berezovoy, V. Lebedev, V. Dzhanibekov, A. Ivanchenkov and J. L. Chretien "They've been simultaneously conducting medical, biological, astrophysical and production technology experiments--the expedition has reached its 'peak.' Additionally, the astrophysical experiments require orienting the space complex on certain celestial bodies; consequently, dynamic operations are necessary. The crew commanders are engaged in this."

It should be added to the aforementioned that these operations are carried out at night--not during "earth nights," of course, but during the "space nights" which occur several times during a twenty-four hour period. The cosmonauts are literally hunting out the darkness--they must photograph faintly luminous objects. Not only moonlight interferes in this regard, but the light inside the space station as well--to the extent that complex operations must be carried out almost entirely by feel.

At the same time, the "Pamir Group" started up yet another device, the "Tsitos-2." Its sequence number was not chosen at random--V. Dzhanibekov, commander of the Pamir Group had worked with "Tsitos-1" on board Salyut-6.

"But then," recalls A. Lepskiy, candidate of medical sciences, "we were studying the overall behavior of microorganisms in space. Today's experiments have a highly practical orientation. We are examining in particular the effect of antibiotics on the so-called conditionally pathogenic microorganisms, whose influence is felt when the human health condition deteriorates. These experiments were set up by a group conducting space biology research in Toulouse and by the Medical and Biological Institute of the USSR Public Health Ministry."

"We have developed several forms of bacteria, including some issued from microflora supplied by the French cosmonaut," French representative N. Muati comments on the experiments. "These strains were thoroughly studied genetically and biologically. Also, various concentrations of antibiotics were prepared. In this way we hope to obtain data regarding changes in sensitivity of bacteria to various forms of anti-

biotics in space. Further difficulty in conducting these experiments was presented by the fact that all the instruments had to be miniaturized, a fully sterile environment maintained and minimum cosmonaut participation required."

Zh. Raffen, a representative of the French National Center for Space Research, tells how these problems were resolved. "We placed the microorganisms in glass ampules about the size of a match. Excess pressure was created inside which cracked the ampules and forced the liquid with bacteria out into a nutrient medium. An antibiotic was then drawn into the packet from polyethylene film. Transparent covers allowed observation of color changes in the nutrient medium during the course of the experiment. Growth of the microorganisms would change the color of the medium from red to orange and yellow. No change in coloration meant that growth of the microorganisms was not taking place--that they were sensitive to the given concentration of antibiotics."

The French "participants in the experiment" were shipped to the USSR from Paris in a special vessel--a biotherm in which constant temperature was maintained. Then the inserts were placed into a biotherm of Soviet manufacture and delivered on board the Salyut-7 space station. There the cosmonauts switched on the "Tsitos" device at a designated time and monitored its cycle of operation--the experiments had to be conducted at a temperature of 37 degrees Centigrade. Then they transferred the insert with six cassettes to "Tsitos-2." Each cassette housed ampules with microorganisms, nutrient medium and antibiotics. J. L. Chretien pressed the button and the experiment began. Analogous apparatus were simultaneously switched on in the USSR and France--experiments in a controlled earth environment were necessary for data comparison. But we'll only learn the results of the experiments when V. Dzhanibekov, A. Ivanchenkov and J. L. Chretien return to earth.

Later still the results of another biological experiment--in the "Bioblok-3" apparatus--will become known. This also is a continuation of efforts conducted earlier. Its purpose is to study the influence of cosmic radiation, especially that of heavy nuclei of galactic origin, upon living organisms--in particular, upon tobacco plant seeds.

It is necessary, of course, that this will require an accurate determination of the physical parameters of radiation that affects the living cells. This is why each biological specimen in "Bioblok-3" is accompanied by plastic detectors and nuclear emulsions which record the trajectories of cosmic radiation particles.

Six biological samples in all were set up within this apparatus--three from France and three from the USSR. Upon return to earth the "Pamir Group" will take one pair, the "Elbrus Group" another. A third pair will remain at the space station up through completion of the basic expedition's stay.

Judging by everything, the mood of both crews has not been affected by the sizable work volume--they are working in friendship, with enthusiasm. To all questions as to how they feel, invariably they reply: "Everything's going just fine!"

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NEW FOOD SELECTION SYSTEM FOR COSMONAUTS IN 'SALYUT-7'

Moscow IZVESTIYA in Russian 3 Jun 82 p 6

[Article by B. Konovalov, special correspondent: "Life in a Starry Home"]

[Text] The "Progress-13" transport ship, which had docked with "Salyut-7" and has now been unloaded, carried replenishments for Anatoliy Berezovoy's and Valentin Lebedev's supply of products for the orbital "epicure" among its other cargo. This flight is the occasion of the first test of an experimental system for feeding the cosmonauts that the specialists call "gastronomical pantry." Standard sets of breakfasts, lunches and dinners were delivered to the crews on board "Salyut-6." And, like it or not, they had to eaten in order that the standard amount of calories be consumed. The consumption of a specific number of calories was a matter of vital importance. However, in the opinion of many cosmonauts who worked on board "Salyut-6" for a long time, such an obligation contributes additional difficulties to the complicated conditions encountered during a flight in space.

As an experiment, therefore, Berezovoy and Lebedev are testing another system that enables a cosmonaut to choose his food freely. The food is now preserved and delivered as separate "units": borshch, foodstuffs, canned fish and meats and various freeze-dried dishes. It is all laid out on separate shelves, as if in a pantry in a house. The cosmonaut himself can select what he prefers to eat on a given day. Of course, what he selects must be within sensible limits. The physicians keep track and see that the ration is still balanced as far as composition and caloricity are concerned. At the end of each week of the flight the crew has to "inspect" its supplies and send the data to Earth for medical monitoring and so that it will be known what products in what amounts need to be sent to the station on the next cargo or manned ship.

"This time the crew will also have a whole series of new things on the menu," was what L.F. Taratorin, chief of the laboratory at the All-Union Scientific Research Institute of the Food Concentrate Industry and Special Food Technology, told me at the cosmodrome. "We, for example, have made many freeze-dried products, to which water is added before they are eaten. We also try to vary the garnishes. The selection of canned foods can include mashed potatoes, peas in a cream sauce, stewed cabbage, or buckwheat porridge. Dishes such as azu and chakhokhbili [translations unknown] are now available in tin cans. Among our new products are cottage cheese with nuts, yogurt and acidophilus paste. The 'Rodnik' system enables the crew to use more water than before and to drink all the coffee and tea, with or without sugar, that it wants. We hope that our dishes will meet with the cosmonauts' approval."

Another innovation in the kitchen department on board the "Salyut" is a small refrigerator with a capacity of 50 liters. Just as at home, if something is left over after a meal it can be put in the refrigerator. Freeze-dried milk and juice can be reconstituted and chilled. If someone wants cold water, that is also possible. Thus, the comforts in these starry homes are being improved from station to station.

The "El'brus" crew members are already beginning to need domestic services. A Soviet-French crew will soon arrive as their guests. This is what we heard during one of the communication sessions:

"Tell Volodya Dzhanibekov to find out how to cut hair, because ours is already beginning to get too long. Tell him to learn how to give us some kind of stylish French haircut."

As we see, the hosts on board "Salyut-7" are already concerned about looking their best when they appear on French television.

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PRESS CONFERENCE ON RESULTS OF SOVIET-FRENCH FLIGHT

Moscow IZVESTIYA in Russian 8 Jul 82 p 3

[Article: "A Handshake in Space"]

[Text] Soviet and French scientists and specialists have written a glorious page in the annals of international cooperation in orbital flight. The scientific expedition on board the "Salyut-7" orbital station, with the participation of the first French cosmonaut, has been successfully completed. This event was the subject of a press conference for Soviet and foreign journalists that was held at the USSR MID's [Ministry of Foreign Affairs] press center on 7 July.

Prominent Soviet and French scientists appeared at the meeting with the correspondents, along with the leaders of the Cosmonaut Training Center and the Flight Control Center and the members of the 10th international crew.

After opening the press conference, Yu.N. Chernyakov, chief of the USSR MID's Press Department, yielded the floor to Academician A.P. Aleksandrov, president of the USSR Academy of Sciences. On behalf of all Soviet scientists he greeted the members of the Soviet-French crew, congratulated them with high awards, and wished them success in the noble matter of conquering space.

The expedition's strenuous program included 14 different experiments in the fields of space biology and medicine, astrophysics, geophysics and the study of materials that had been prepared by Soviet and French specialists. One scientist declared that there is no doubt about the importance to both fundamental and applied sciences of the results obtained during this week in space. In connection with this, we should mention the considerable contributions to the development and realization of the expedition's scientific program made by the collectives of the USSR Academy of Sciences' Institute of Space Research and Institute of Terrestrial Magnetism, the Ionosphere and Radio Wave Propagation and the USSR Ministry of Health's Institute of Medicobiological Problems.

"This flight into space under the flags of the USSR and France," stated the president of the USSR Academy of Sciences, "is undoubtedly the high point in the collaboration of Soviet and French scientists and specialists, but the first step of the ascent to this peak began as far back as 16 years ago, with the signing of an intergovernmental agreement on scientific and technical cooperation. One of the first signs of this cooperation was the experiments conducted during a joint study of our planet's magnetic field at coupled magnetic points on Earth. In all during this time, about 40 large-scale joint programs were carried out.

"However, the Soviet-French manned expedition required not only a well-prepared scientific program, but also flawlessly functioning equipment. I visited the Flight Control Center at Baykonur cosmodrome more than once and was frequently amazed at how efficiently the huge flight control center complex functions and how, among all the thousands of events, commands and operations, there were never any breakdowns.

"Both Soviet and French scientists," said A.P. Aleksandrov, "have already reported to us how completely satisfied they are with the amount of information that was obtained and transmitted for processing to scientific centers in the USSR and France. I would like to mention that we have not yet recovered all this expedition's 'baggage,' since part of the French instruments stayed on board the station, where its permanent hosts--A. Berezovoy and V. Lebedev--are continuing to work with them."

After giving their due to all the collectives that supported the successful conduct of the Soviet-French scientific mission, Aleksandrov gave high marks to the mass information agencies of the USSR and France for their operational and objective interpretation of this great space epic, which has become a clear example of the fruitful and mutually profitable scientific relationships between our countries for the peaceful conquest of space and a symbol of the traditionally friendly relationships between the peoples of the USSR and France.

Aleksandrov was followed by Professor (Hubert Curien), president of France's National Center for Space Research, who noted that the completed flight demonstrated the high qualifications of Soviet engineers and technical specialists in all stages. "I would like to thank all the Soviet people who received us at Baykonur cosmodrome and other places related to the flight," the scientist said. "For us French specialists, of particular interest was the possibility of observing the flight from the medical and biological viewpoints. In addition to that, we were offered the opportunity to take advantage of what Soviet specialists already know in this field.

"It is pleasant to be able to say that we observed not five individual cosmonauts working in space, but a unified crew that interacted excellently. This contributed to the high quality of the realization of all the work. Our next joint project," said Professor Curien, "will be related to the investigation of Venus. We hope that it will be followed by other experiments and flights, including manned ones. Our meetings with Soviet scientists in connection with the flight that has just been completed will continue. In October we will meet in Kishinev, where we will review the results of our experiments and discuss plans for collaboration in the future."

Crew Commander V.A. Dzhanibekov told the journalists about the details of the torrid week in space and the working and living conditions in their space home. "My main impression," he noted, "was that the work was done in a spirit of harmonious curiosity. I recall how five people were working in the orbital station for the first time. In addition to the scientific program one of our assignments was to observe how the systems coped with providing such a large crew with heat and air.

"As commander, it is pleasant for me to report to you that from the very first hours after our arrival at the station the crew went to work immediately, without any kind of preliminary organizational meeting. (Jean-Loup Chretien) was especially active. We didn't hurry him much during those first hours, knowing that he had to get accustomed to weightlessness. However, he not only hurried himself, but hastened to the assistance of anyone who needed it.

"As far as the organization of the work on the station is concerned," V. Dzhanibekov emphasized, "the main 'dispatcher' for this week-long watch in orbit was, of course, the log books, in which the program for each cosmonaut was entered by hours. However, everything cannot be foreseen on Earth, and under the conditions of the saturated scientific program it was necessary to make changes in the daily work schedule. For example, the participation of the entire, united crew--all five cosmonauts--was needed at those moments when we were reorienting the station for the next experiment."

Did anything funny happen during the flight? "In the station we worked merrily every day," said the commander. "However, I remember moments--particularly when we were in complete darkness, which was required by the specific nature of several experiments--when all five of us literally exploded into laughter, such as when two or three of us would bump together in our main uncontrolled intersection, which was the hatch between the ship and the station. We agreed that until we could put up a traffic light there, we would use flashlights."

Flight Engineer A.S. Ivanchenkov then took the floor. He talked about the program of scientific and technical experiments carried out by the Soviet-French crew, dwelling in particular on a large section of it that stipulated a study of the atmosphere and a study of intragalactic formations and gas clouds found in various constellations. A.S. Ivanchenkov praised the quality of the French "Piramig" and "PSN" cameras, which have excellent optical characteristics and shielding against interference. According to him, the successful realization of the surveys was facilitated to a considerable degree by the "Salyut-7" station's autonomous orientation and stabilization system, as well as the excellent conditions for research that were created in it by its designers.

Next, it was French Cosmonaut-Researcher Jean-Loup Chretien's turn. "My friends Volodya and Sasha talked so completely and interestingly about our work and life in space," he said, "that the only thing left for me to do is to answer journalists' questions."

To the question "What was the scientific value of the flight?" Chretien responded that all three factors on which the success of the scientific mission depended were favorable. The quality of the preparation of the scientific experiments, many of which were being conducted in orbit for the first time, was high. The technical capabilities, or the adaptability of the orbital station to unique scientific experiments, also received high marks. And, finally, there are the scientists, for whom both the quantity and quality of the materials transmitted to Earth and brought down in the descent vehicle raise hopes that the expedition will contribute important results to various branches of space science.

What would he like to say to his countrymen about his two years of life and work in the Soviet Union? In answering this question, the French cosmonaut said:

"The main impressions that I will always retain from these remarkable two years can be reduced to a single one. All of the Soviet people I met are ordinary and hospitable people who work selflessly. Friendliness and patience on the path to the goal are, in my opinion, the characteristic features of Russians."

"During the flight did you feel the friendly attitude of the Soviet people toward the French, or did distance prevent you from noticing this?"

"We were very far from you as far as distance was concerned, but I felt and still do feel this sincere friendship. In space I felt the crew's friendship, which was a brilliant reflection of the friendship between our peoples."

"I think that participation in the joint experiment," Zhan-Lu Kret'yen added, "will give France the opportunity to cover quickly those stages of the conquest of space that took long years for other countries."

Academician R.Z. Sagdeyev, director of the Institute of Space Research, told the journalists about the long-term program of space research in the USSR. He mentioned that this program allows for a harmonious combination of the interests of basic and applied science. The realization of joint Soviet-French projects also has an important place in it.

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X-RAY ASTRONOMY RESEARCH ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 24 Jul 82 p 2

[Article by B. Konovalov, special correspondent of IZVESTIYA: "Orbital Astronomers"]

[Excerpt] Astronomic observations occupy a rather important place in the program of work aboard Salyut-7. It is the most advantageous to examine from spacecraft the part of the spectrum of electromagnetic radiations that our atmosphere does not let through to earth's surface. On Salyut-7, x-ray astronomy was given the main place in extra-atmospheric studies.

This branch of science is celebrating a unique anniversary: 20 years ago, x-radiation of the sky was recorded for the first time from a rocket and the first bright x-ray source, Scorpia X-1, was discovered in the Scorpio constellation. In 20 years, hundreds of x-ray sources have been already discovered by means of rockets, satellites, manned spacecraft and stations, most of which are the most compact and hottest objects in the universe, with a temperature of 30-100 billion degrees. We refer, for example, to such unusual and extremely interesting objects as neutron stars, "black holes," where huge gravity prevails. X-radiation is attracting astrophysicists because it appears close to the centers of release of energy, which means that it contains information about the most intensive and nonstationary processes in the universe. It is not by chance that research expressly in the x-ray range turned out to be, perhaps, the most informative and leading area of extra-atmospheric astronomy.

During television transmissions, when the "Elbruses" show us their "apartment," a large cone can be seen in the middle of the working compartment. This is the so-called module [compartment] for scientific equipment, much of which is taken up by a set of x-ray telescopes.

From Salyut-7, the universe is examined by means of an RT-4M mirror x-ray telescope, which was developed at the Institute of Physics, USSR Academy of Sciences, and SKR-02 spectral x-ray telescope, developed through the joint efforts of several organizations headed by the Institute of Space Research, USSR Academy of Sciences, and the State Astronomical Institute. These telescopes supplement one another. The RT-4M permits recording so-called soft

x-radiation, while the SKR-02 is for harder radiation, which is inherent in hot x-ray sources.

One of the developers of the SKR-02, Yevgeniy Karlovich Sheffer, senior scientific associate at the State Astronomical Institute tells the reporters: "The studies that are being conducted at the present time by the 'Elbruses' aboard Salyut-7 are a continuation of work started already on Salyut-4. There, the Filin x-ray telescope had been installed, which yielded a number of quite valuable results. So-called proportional counters are the 'heart' of the new telescope, like the Filin. They consist of rectangular boxes filled with xenon-methane gas, with an anode filament extended in the middle. When x-radiation penetrates into such a box through the beryllium foil window, it initiates an electrical discharge, which is recorded, converted to digital form and the data are transmitted to earth via the telemetry channels. Honeycomb collimators permit isolation of a specific visual field in the telescope. The angle of vision of the instrument constitutes 3 degrees. In all, there are 21 counters in the telescope which are combined into three detection devices. The sensitive receiving surface of the SKR-02 constitutes an area of 3000 square centimeters. For the same of comparison, we can mention that this surface was only 450 square centimeters in the Filin. At present, the SKR-02 is the most sensitive x-ray telescope of all those operating in near-earth space. It permits recording x-radiation over a wide range of energy."

We learned from the specialists that Berezovoy and Lebedev have already conducted eight experiments in x-ray astronomy, and a number of sources of interest to scientists have been examined. They include so-called Seyfert galaxies, which are notable for intensive nonstationary processes, double systems, where stars that are visible and invisible in the optical range are next to one another, and bursting x-ray sources which produce bursts of radiation with specific periodicity. And this is only the beginning, the first trial of the new x-ray telescopes.

On Salyut-6, the main place in astronomic research was given to a submillimeter telescope, whereas Salyut-7 is specializing in the shorter wave, x-ray range.

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RYUMIN INTERVIEWED ON WORK OF COSMONAUTS, FLIGHT CONTROLLERS

Moscow OGONEK in Russian No 40, 2 Oct 82 pp 16-17

[Interview with Valeriy Viktorovich Ryumin, USSR pilot-cosmonaut, by Rimma Kornaushenko: "Profession: Cosmonaut"; date and place not given]

[Text] On the eve of the 25th anniversary of the launching of the first Soviet artificial Earth satellite, I met with Valeriy Viktorovich Ryumin, who holds the world record for time spent in space. On his first flight in the "Salyut-6" station, in 1979, he worked as the flight engineer for 175 days and 36 minutes. The following year he replaced the ailing Valentin Lebedev just before the expedition began. This time he and Leonid Popov spent 183 days, 15 hours and 16 minutes on board the "Salyut-6." Valeriy Ryumin is now a spaceflight controller.

[Question] Valeriy Viktorovich, more than two decades have passed since the appearance of the new profession of cosmonaut. In your opinion, what kind of a person is the cosmonaut of the '80's? For example, at one of the last preflight training sessions for Svetlana Savitskaya and Aleksandr Serebrov I heard a curious dialog. While demonstrating the "Tavriya" experiment, the methodologist mentioned that it was said that for one of the stages the experiment can be done the way it is written in the instructions or maybe differently. Although this variant did not affect the essence of the experiment, nevertheless Svetlana suggested that it should certainly be included in the instructions. I then looked over the instructions for other experiments. It amazed me how scrupulously each of them was written. It seems that today's cosmonaut is, above all, an ideal executor.

[Answer] It may be that this is paradoxical, but only at first glance. On today's level of diversified planning for space natural science research, hundreds of laboratories, institutes, observatories and design offices--in many other countries as well as our own--participate in the investigative work done on board the "Salyut" stations. The experiments are prepared by specialists of the very highest class, be they biologists, astronomers, or physicists. In their own fields they, as it is said, have it right at their fingertips. But a cosmonaut, although he does know his own field and knows how to perform different dynamic operations, in no way can be a professional in so many different areas. This means that there is only one way to do things. An experiment has to be methodically divided into deliberately elementary parts, so that a person who has had even just a little preflight experience in dealing with the object of study can perform it successfully in orbit. I will give

you an example that is completely divorced from space technology. In his book, Arsen'yev relates how his hero, Dersu Uzala, is far ahead of his companions out on the tayga. The road forks and Dersu, wishing to indicate the direction he took, bends a branch. He thinks that the ones following him will understand this. But he was mistaken and they did not notice the branch. Then, at another time in the same situation, Dersu piles up branches on one road and indicates the one he took with a log.

By this example what I want to say is that where even a twig tells much to those in the know, for a person in another circle or another profession the path must be explained accurately and in detail. And the cosmonaut, in turn, must carry out all the instructions just as absolutely accurately and in as much detail.

Yes, a cosmonaut is an executor, but not just that. No matter how well educated and knowledgeable the specialist preparing the experiment and the equipment for it is, he still thinks "terrestrially." The model functions perfectly on Earth, everything is normal, and no one is concerned, but in weightlessness--a malfunction. You calculated on paper but forgot about the ravine, as they say. The terrestrial techniques do not work. How do we get out of this situation?

Having irreproachably--I repeat, irreproachably--performed all the indicated instructions, a person in orbit should still seek out any imperfection in them, depending on the specific conditions. Knit your brow, as they say, and find another way, your own way. That is no longer just execution, but a qualitatively new and creative approach.

Here's an example for you. The first emission layer is located in the equatorial zone, at an altitude of 80-100 km. A reddish glow sometimes appears in it. Many people have observed it. The scientists thought rather firmly that it is one of the first layer's fluctuations; that is, a random deviation. But Georgiy Grechko, working in orbit, did not agree with the authorities and observed this phenomenon at night for a long time. He drew Yuriy Romanenko into his "adventure" and got into two disputes with the doctors by violating the regime established for him.

As a result, the cosmonauts brought back to Earth descriptions of the glows, measurements of their brightness, and evaluations of the spectral color, all of which made it possible to establish an interrelationship between the glow and in increase in solar activity. It became clear that the phenomenon could in no way be related to the rather well-studied first emission layer. The cosmonauts proved that the equatorial zone is worth of the most serious research, just as the polar zone is. Such investigations were then conducted by all expeditions and I, on my own flights, was concerned with this phenomenon. Interesting material was obtained. Such observations have now become part of the scientific program for the "Salyut-7."

I wish to say that in the rigid schedule of the flights there is some time that is free from the mandatory program. True, there's not very much of it, but nevertheless people have a change to formulate their own experiments in orbit. This is creativity! The main thing there is to produce the idea. Formulating a problem sometimes proves to be more complicated than solving it. If one crew does not solve it completely, the next one will pursue it further.

In this case it is important not just to see something and make a note of it. Earth will not trust your emotions. It is important to give an adequate description,

using photographs, facts, recordings and numbers. Facts are something that can help you review techniques and change programs. There are plenty of examples of this. For instance, right now a station can function regularly in the gravitational stabilization mode; that is, fly with its longitudinal axis pointed permanently at Earth, which is very economical as far as fuel is concerned and convenient for some investigations. However, this mode was found almost accidentally by one of the expeditions while it was performing dynamic operations. I said almost accidentally, because in orbit a person must "sniff the air," like a dog, and be in a state of acute readiness to discover anything new.

There you have it: the "ideal" cosmonaut must have the qualities of a flawless executor-experimenter and an inquisitive scientist. Although I do not like the word "ideal," the more so in the combination "ideal cosmonaut." I think that in the sky and on Earth we simply need just the same kind of people: talented workers.

[Question] Well, those in space are that. I have in mind not only cosmonauts, but but also technological specialists. What a ship they have created in the "Soyuz-T"! Please tell us how it differs from the "Soyuz."

[Answer] It can be said that we now have a new series of excellent machines: the "Soyuz-T" has performed brilliantly in all seven of its launches. The only unfortunate thing is that it carries the old name. It should have the same ring, but be different.

The new ship has not yet revealed all of its capabilities, but it has given us grounds for thinking that we have a reliable foundation for new space research. Although up until now we have only used it as a transport ship, as a matter of fact it is capable of independent, autonomous flight. In this ship we have found additional possibilities in literally every working section, particularly during docking.

Using an exaggerated example, I will try to show the difference between the "Soyuz-T" ships and the old "Soyuz." Let us say that a commander gives a platoon of soldiers the following command: to the right, forward, to the left, forward. The soldiers don't know which way to go; the commander does. That is the way the "Soyuz" used to fly an approach, under the command of the Flight Control Center. But the "Soyuz-T" knows both how to fly the approach and the final point of its journey. It is like a man, let us say, who is going home. While still far from home he changes his route, but nevertheless he arrives home automatically, without even thinking.

The "Soyuz-T" is a very intelligent and sensitive machine, and it sometimes seems as if the specialists "overrefined" it. We at the TsUP [Flight Control Center] have to think about thousands of characteristics and all the possible parameters before we put a new program in it. As they say, the faster you want to ride, the slower you should put the harness on. As it has turned out, the "Soyuz-T" has made life easier for the cosmonauts and harder for us. This is also good.

[Question] The TsUP, like a thoughtful mother, watches over everyone in orbit. And sometimes it has to act like a hairsplitting mother-in-law. One day when inventory was being taken the operator asked everyone: "Where did the regenerators get to? And the films, also." It's always one thing or another. You were in space not too long ago and this vigilance probably irritated you and diverted you from more important matters. But now you're on the other side of the fence...

[Answer] Neither in space nor in orbit nor in the TsUP are there any trivial details, nor can there be. I understood this on my first flight and even more so on my second. Inventorying is a tedious and tiring job. You have to look for everything and report to Earth. Just consider this: the "Salyut" has already been visited by three "Progress" cargo ships. This means that it was necessary to put away six tons of cargo and remember what instruments are where, where the spare parts are, where the food and clothing reserves are. No one can remember all that, but the TsUP remembers everything and knows everything.

Aleksey Stanislavovich Yeliseyev was the flight controller for almost 10 years. I inherited an already-moving train and had to take timely measures for it to continue moving at the same speed. Right now we're additionally automating all the positions with the most modern machines. Most of our specialists stick with us and have been working here for 5-10 years, and we try to integrate our younger workers smoothly.

However, I would also like to mention that the Flight Control Center is not only what viewers see on the television screen. The TsUP would be blind and deaf if we did not have tracking stations on land and at sea. Our successes in space are a combination of human will, courage and knowledge and the perfection of technology.

[Question] Valeriy Viktorovich, it's not long now until the flight of Anatoliy Berezovoy and Valentin Lebedev will come to an end. Tell us in more detail about the scientific program that has been carried out.

[Answer] The amount of work that has been done is quite large, but I'll dwell on just a few aspects of it.

The "Salyut-7" is carrying equipment from the Soviet Union, the countries of the socialist concord and France. Work in astrophysics and geophysics has been done on a broad front. Atmospheric investigations of the polar auroras, noctilucent clouds, phenomena in the second emission layer and the state of Earth's cloud cover are being carried out successfully.

The goal of the astrophysical research is to register weak galactic and extragalactic sources on highly sensitive film and obtain new information about them, as well as to find new, unknown, very weak sources. We already have about 30 hours of recordings of surveys of the celestial sphere and, it seems, have succeeded in discovering two new sources. The cosmonauts observed and recorded such constellations as Ursa Major in the region of the North Star, the Crane, the Magellanic Cloud, Cygnus and others. They also studied the characteristics of a variable source in the constellation Draco that is near the center of the galaxy. The comet (Ostin) in the Southern Hemisphere was studied from a space station for the first time. The counteraurora in the Northern Hemisphere was photographed for the first time from the "Salyut," during the visit of Svetlana Savitskaya.

Such research is difficult to carry out. It is necessary to find the source and track it so that the station is kept in a certain position relative to it. Everything is in darkness and only a flashlight can be turned on from time to time, since the recording equipment is very sensitive to light. This work is done when the station is in the Earth's shadow. The nights in space have now become longer, as the crew has gained experience, and "during one shadow," as we say, the cosmonauts can succeed in photographing two and sometimes three sources.

Experiments in completely new branches of science are making an appearance. For one, there is the "Tavriya" experiment of which you spoke. It was developed by specialists from the Crimea. For the first time in weightlessness, an attempt was made to separate a mixture of different biologically active substances into several superpure components with new and unique properties, using electrophoresis. If the experiment succeeds it will be beneficial for the national economy, particularly as producing new and highly effective medicines is concerned. It is still early to talk about the results, but it seems that the ones obtained so far give us grounds for hope.

On their 78th day, Lebedev and Berezovoy went out into space. For two hours they studied the possibilities of conducting technological operations outside the station.

On board the "Salyut-7" the Soviet "Magma" unit, with a F- -ch recording system, has already been used for 85 hours. The most variegated com...ations of materials--lead and copper, aluminum and indium and others--were studied.

The Flight Control Center has received more than 70 reports from the crew that are of value to agricultural workers, fishermen, geologists and meteorologists. They confirmed these reports with both moving and still picture surveys.

As on each flight, a great deal of attention is being given to medical research. For this purpose, the station carries the most modern diagnostic equipment. When the last visiting crew was working, the doctors did not detect any differences in the male and female bodies under spaceflight conditions. It is true, of course, that Savitskaya is no ordinary woman. She has spent several thousand hours in airplanes and, consequently, was prepared for weightless conditions. Well, 19 years ago we went on the defensive and now you women have broken through and aren't stopping. I think that there will be more flights with women participating.

[Question] What about biological experiments? At one point you reached the very bitter conclusion that "in space only a cosmonaut can survive."

[Answer] Yes. I was and am somewhat pessimistic about this. On both flights we took along seeds of the most variegated plants. There were those that the biologists recommended and some that we cosmonauts carried on board almost as contraband. We planted them, everything was all right, and they grew. Before they matured, however, they withered away. And we tried everything we could think of! True, on the second flight, on Lenny Popov's birthday, an arobidopsis blossomed and the biologists called it a "model" flower. The plant was a tiny one and the little flowers were fragile and not very pretty, but were we happy! We guarded it and cherished it. To no purpose, however, because it turned out to be sterile.

Not long ago Lebedev reported from orbit that this same arobidopsis had produced seeds. I almost didn't believe it. The visiting expedition brought them back to Earth. The biologists say that yes, these are really and truly seeds--the first after all these years. But let us put these little seeds in the ground and see if they sprout, and then we'll know.

[Question] Valeriy Viktorovich, you--in my opinion, are envious. Perhaps you will fly in space again. Is your pressure suit in one piece?

My pressure suit was given to Komsomol'sk-na-Amure. It recently celebrated its 50th birthday, and I myself was born 43 years ago.

As far as my flying again is concerned...well, it's not evening yet...the Flight Fitness Committee passed me, and if I need a pressure suit, our space tailor's shop will whip up one for me. True, from time to time all the dockings, redockings and launches excite me even here on Earth no less than when I was up there on board the "Salyut."

Finally, it isn't important where we work: a design office, the TsUP, in space. It is important to work so that space not only justifies all the expenditures, but is beneficial for Earth and yields a profit. So that our country, which launched the first artificial Earth satellite and gave birth to Yuriy Gagarin, has a strong and reliable space fleet.

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CHRONOLOGY OF 'SALYUT-7' FLIGHT

[Editorial Report] The Soviet New Agency TASS reports the following information on activities connected with the flight of the "Salyut-7" space station.

19 Aug

At 2112 hours Moscow time on 19 August the "Soyuz T-7" space ship was launched in the Soviet Union. The crew is composed of ship commander Pilot-Cosmonaut of the USSR Colonel Leonid Ivanovich Popov, flight engineer Candidate of Technical Sciences Aleksandr Aleksandrovich Serebrov and Cosmonaut-Researcher Svetlana Yevgen'yevna Savitskaya. The flight program includes docking with the "Salyut-7"--"Soyuz T-5" complex and performance of a program of research and experimentation with cosmonauts Berezovoy and Lebedev who have been aboard the complex since 14 May 1982. The crew of "Soyuz T-7" underwent normally the insertion into orbit and transition to the state of weightlessness. (Moscow PRAVDA in Russian 20 Aug 82 p 1)

20 Aug

By 1200 hours Moscow time the "Soyuz T-7" had completed ten revolutions around the earth. The crew members are continuing to prepare the ship for rendezvous with the orbital complex in accordance with the planned program. After an orbital correction the flight parameters of "Soyuz T-7" are: apogee, 280 kilometers; perigee, 228 kilometers; period of revolution, 89.5 minutes; orbital inclination, 51.6°. Aboard the "Salyut-7"--"Soyuz T-5" complex, cosmonauts Berezovoy and Lebedev are preparing for the upcoming docking with "Soyuz T-7". (Moscow PRAVDA in Russian 21 Aug 82 p 1)

At 2232 hours Moscow time on 20 August the "Soyuz T-7" docked with the "Salyut-7"--"Soyuz T-5" complex. The five-member crew, with a woman-cosmonaut among them for the first time, began carrying out the joint research program. The scientific program of the flight is scheduled for seven days and includes astrophysical and technical experiments, observation and photography of the earth's surface in the interests of various branches of the national economy, and a large volume of biomedical research and experiments. According to telemetry data, the on-board systems of the "Salyut-7" station are functioning normally. The five cosmonauts are feeling well. (Moscow PRAVDA in Russian 22 Aug 82 p 1)

22 Aug

Cosmonauts Berezovoy, Lebedev, Popov, Serebrov and Savitskaya are continuing with the planned studies and experiments aboard the orbital complex. Yesterday the members of the visiting crew underwent control medical checks. Technical experiments were also performed to determine characteristics of the atmosphere near the complex and to measure parameters of the microatmosphere inside the station. On Sunday the workday in orbit started at 0900 hours and lasted until midnight. After checking the on-board systems of the station, the crew began the planned work program. Today's program includes medical studies, technical experiments and a television report. In the first half of the day Svetlana Savitskaya underwent a study with regard to sensitivity of the vestibular apparatus and the brain in the period of adaptation to weightlessness as well as the bioelectric activity of the heart during physical exercise on the veloergometer. After lunch, cosmonauts Popov and Serebrov performed the "Ekhograf" experiment in which indices of cardiac function are determined. The cosmonauts of the main expedition (Berezovoy and Lebedev) engaged themselves with technical servicing of the station, preparation of research equipment for work tomorrow and performing exercises on the training equipment. In accordance with the flight program, cosmonauts Popov, Serebrov and Savitskaya will return to earth in the "Soyuz T-5" ship. In preparation for this, the cosmonauts dismounted their individual seat supports in the "Soyuz T-7" and installed them in the descent craft of "Soyuz T-5". The flight is going according to plan; the cosmonauts are feeling well. (Moscow PRAVDA in Russian 23 Aug 82 p 1)

23 Aug

Medical examinations of the visiting crew during their first days aboard the station have shown that the process of adaptation to weightlessness is proceeding normally. The third day on the station will be devoted to scientific studies by all five cosmonauts. The "Tavriya" experiment to study separation of tissue cells by electrophoresis is continuing. The crew members are monitoring the experiment and recording it on film and video tape. The cosmonauts have performed an experiment to evaluate the interaction of organic systems providing spatial orientation and coordination of movement in weightlessness. Today the visiting crew will perform a series of experiments with the "Piramig" apparatus for further study of the earth's atmosphere, the interplanetary medium, and galactic and extra-galactic radiation sources. Today's program also includes geophysical studies on earth's natural resources and technical experiments for development of methods of space navigation. (Moscow PRAVDA in Russian 24 Aug 82 p 1)

24 Aug

Today the visiting crew is performing the latest cycle of studies with the "Piramig" apparatus. With the aid of the EFO-1 electron photometer developed by Czechoslovak specialists the cosmonauts are performing an experiment to determine the density of aerosol layers of space origin in the atmosphere of the earth. Orientation and stabilization of the space complex for performance of these experiments are being performed by cosmonauts Berezovoy and Lebedev. The two members of the primary crew are also assisting their comrades, filming

the joint activity and monitoring the station's on-board systems and equipment. As part of the program of medical studies, in the first half of the day a study was made on Svetlana Savitskaya to determine sensitivity of the vestibular apparatus and functional activity of the brain. A study of Aleksandr Serebrov is planned to determine cardiovascular system indices by the ultrasonic method using the "Ekhograf" apparatus. The study will be made with use of the "Pnevmatik" prophylactic unit which makes it possible to normalize blood circulation in conditions of weightlessness. The planned program of biotechnical experiments on the "Tavriya" unit has been fully completed. In the final series of experiments the electrophoretic separation of the mixture of biologically active substances was recorded with the use of holography. The results of the experiments will be used to develop methods for obtaining superpure medical preparations and biological stimulators in conditions of weightlessness. (Moscow PRAVDA in Russian 25 Aug 82 p 1)

25 Aug

A large part of today's program will be devoted to experiments with the "Piramig" and "PSN" apparatus in order to study the structure of the earth's atmosphere, interplanetary space and galactic and extra-galactic radiation sources. Before beginning this work the cosmonauts will calibrate the apparatus using the sun. The photo survey will be performed in the shaded sector of the orbit. The visiting crew has completed the latest cycle of medical studies. A study of the blood circulation of Svetlana Savitskaya was performed. Cosmonauts Popov and Serebrov performed an experiment to evaluate interaction of the sense organs and the motor system of the organism which provide spatial orientation and coordination of movement in weightlessness. Today's schedule also includes measurement of atmospheric parameters in the station compartments and visual observation of the earth's surface. In the evening the crew held a television press conference for the journalists at the Flight Control Center. (Moscow PRAVDA in Russian 26 Aug 82 p 1)

26 Aug

The visiting crew is performing the final experiments in the scientific program and preparing for the return to earth. Today the cosmonauts performed another cycle of experiments using the "Piramig" apparatus and the EFO-1 electron photometer. They also collected samples of air and microflora in the station's compartments for subsequent laboratory analysis. The "Soyuz T-5" transport ship, in which cosmonauts Popov, Serebrov and Savitskaya will return to earth tomorrow, is being prepared for the descent from orbit. The cosmonauts are checking the ship's on-board systems and are transferring and packing experimental materials in the descent vehicle. Used equipment is being stowed in the ship's orbital compartment. Among the items returned to earth will be movie film, cases with biological objects and technical documentation. (Moscow PRAVDA in Russian 27 Aug 82 p 1)

27 Aug

At 1904 hours Moscow time on 27 August, cosmonauts Popov, Serebrov and Savitskaya returned to earth. Cosmonauts Berezovoy and Lebedev are continuing work aboard

the "Salyut-7" station. The "Soyuz T-5" descent vehicle landed 70 kilometers northeast of the town of Arkalyk. The cosmonauts are feeling well. During the flight the cosmonauts photographed various land and water areas and performed a number of technical experiments. Astrophysical and geophysical experiments were continued with the use of Soviet, Czech and French apparatus. Of great importance were the biotechnical experiments performed for the first time on the station. In these experiments, methods were developed for obtaining super-pure biologically active substances in conditions of weightlessness. Medical and biological studies occupied an important place in the crew's work program. These studies produced a large volume of new scientific data. No substantial differences were found in the reactions of the male and female organisms to the influences of space flight. The scientific data obtained in the course of the flight will be used in the interests of various branches of science and the national economy and for the further development of manned space flights. (Moscow PRAVDA in Russian 28 Aug 82 p 1)

29 Aug

Cosmonauts Berezovoy and Lebedev are now in their 108th day in space. In accordance with the flight program, the "Soyuz T-7" was redocked today in order to free the docking module on the equipment module of the station for further resupply and refueling operations. After checking the on-board systems, the cosmonauts transferred to the ship and closed the transfer hatch. At 1847 hours the "Soyuz T-7" separated from the "Salyut-7" station. At the scheduled time the mutual search and rendezvous systems of both spacecraft were activated. The station performed a 180 degree turn after which the "Soyuz T-7" docked to the transfer compartment of the station. The cosmonauts checked the docking seal, opened the hatch and transferred back into the station. On Monday the cosmonauts will have a day of rest. (Moscow PRAVDA in Russian 30 Aug 82 p 1)

31 Aug

The cosmonauts are in the 110th day of their orbital flight. A large amount of the crew's program is devoted to geophysical studies in the interests of science and the national economy. The crew members are performing visual, instrumental and phtographic studies of the earth's surface to collect and transmit to the ground current data on natural resources and meteorological phenomena. Today, for example, the cosmonauts are studying the dynamics of development of dust storms in Kazakhstan, the North Caucasus, the Ukraine and Turkmenia and are observing gas-bearing regions in the Caspian area. Today's schedule also includes physical exercises and rest periods. This evening an orbital correction maneuver will be performed using the engine unit of the station. (Moscow PRAVDA in Russian 1 Sep 82 p 1)

3 Sep

Cosmonauts Berezovoy and Lebedev have begun their 17th week aboard "Salyut-7". In the past days they have carried out the scheduled cycle of experiments in the program for study of the earth's natural resources and environment. They have also performed a number of maintenance operations on the station. The present orbital parameters of the "Salyut-7"--"Soyuz T-7" complex are: apogee, 340 kilometers; perigee, 321 kilometers; period of revolution, 90.9 minutes; inclination, 51.6 degrees. (Moscow PRAVDA in Russian 4 Sep 82 p 1)

7 Sep

The cosmonauts are completing the latest cycle of geophysical experiments. Previous manned flights demonstrated the efficiency of space-based studies of the earth's surface to determine surface features and for more efficient planning of prospecting for mineral deposits. With these aims the cosmonauts observed and photographed large ring formations and fractures of the earth's crust in the region of Lake Balkhash and in the Far East. They also evaluated the condition of forests in the Altay region, the Carpathians, Amur Oblast and the area east of Lake Baykal. They also studied glaciers and ice conditions in mountainous regions of the country. Today the crew will perform studies of characteristics of the earth's atmosphere. Plans for tomorrow include astrophysical studies using the X-ray apparatus on the station. (Moscow PRAVDA in Russian 8 Sep 82 p 1)

10 Sep

The cosmonauts have now been aboard the "Salyut-7" station for 120 days. Today the crew will have a scheduled medical check-up. Reaction of the cardiovascular system to dosed physical loads is being studied with use of the "Reograf" and "Beta" recording apparatus. In order to achieve optimum planning of the work and rest regime for the cosmonauts, their pulse rate and body temperature are measured both at rest and during performance of work. During the day the crew will also measure rates of air flow in the station to evaluate the microclimate in its various zones. Experiments in growing higher plants are also continuing. At present, growth dynamics of cultures of wheat and corn tissue are being studied, as well as the effect of an electrical field on the development of peas. In addition, Berezovoy and Lebedev are conducting experiments with garden plants such as cress, dill and kale. Tomorrow's schedule includes visual observations, cleaning the station quarters and a shower. In a two-way television session the cosmonauts will talk with their families. (Moscow PRAVDA in Russian 11 Sep 82 p 1)

14 Sep

Cosmonauts Berezovoy and Lebedev have now been in space for 4 months. During this time they have performed a wide range of experiments, hosted 2 visiting crews, performed an EVA, received 2 "Progress" cargo ships and have redocked the "Soyuz T-7" transport ship. A large part of today's schedule is devoted to geophysical experiments in the program for study of earth's natural resources. In addition to the MKF-6M and KATE-140 cameras the cosmonauts are using the high-resolution "Niva" apparatus which makes it possible to videotape observed areas and transmit current data to the ground during TV sessions. (Moscow PRAVDA in Russian 15 Sep 82 p 1)

17 Sep

The cosmonauts are completing their 18th week aboard "Salyut-7". The latest cycle of research with the X-ray spectrometer has been completed. The goal of this research is to observe new sources of galactic radiation. On assignment from geologists, the crew observed and photographed fractures in the earth's

crust in the Ukraine and in the areas of the Aral Sea and Lake Balkhash. Today the cosmonauts are continuing studies of the earth's atmosphere using the electron photometer and motion picture and still photography. They will also perform medical experiments, tend the plants in the "Oazis" and "Svetoblok" units and exercise on the veloergometer and running track. (Moscow PRAVDA in Russian 18 Sep 82 p 1)

18 Sep 82

At 0859 hours Moscow time on 18 September the "Progress-15" automatic cargo ship was launched. The purpose of the launch is to deliver various cargo and expendibles to the orbital station. "Progress-15" was inserted into an orbit with the following parameters: apogee, 258 km; perigee, 195 km; period of revolution, 88.7 min; inclination 51.6 degrees. (Moscow PRAVDA in Russian 19 Sep 82 p 2)

20 Sep

At 1012 hours Moscow time on 20 September the "Progress-15" docked with the "Salyut-7"--"Soyuz T-7" complex. The cargo ship docked at the instrument compartment of the station. "Progress-15" delivered fuel, equipment, materials for scientific research and life support, as well as mail for the crew. (Moscow PRAVDA in Russian 21 Sep 82 p 1)

21 Sep

Cosmonauts Berezovoy and Lebedev have completed 131 days aboard the orbital complex. Today the cosmonauts are unloading the "Progress-15". Preparations have begun for refueling the unified engine unit of "Salyut-7". Compressed nitrogen has already been pumped out of the fuel tanks. This operation was performed by commands from the Flight Control Center; the cosmonauts monitored the procedure. During the day the cosmonauts will perform a number of experiments with the "Astra-1" mass spectrometer apparatus. Another stage of research will begin with the newly delivered biological samples. (Moscow PRAVDA in Russian 22 Sep 82 p 1)

24 Sep

Cosmonauts Berezovoy and Lebedev have begun their 20th week in orbit. The cosmonauts have been transferring items into the station from the "Progress-15" ship and storing used equipment in the emptied compartment of the ship. Refueling of the station's unified engine unit has been completed. Today's schedule includes medical studies. The cosmonaut's cardiovascular systems will be checked under conditions of simulated hydrostatic pressure created by the "Chibis" vacuum suit. Heart activity will be evaluated using the ultrasound method. A number of biochemical studies will also be performed. (Moscow PRAVDA in Russian 25 Sep 82 p 2)

28 Sep

Today cosmonauts Berezovoy and Lebedev are performing functional checks of units and systems of the station, preparing scientific apparatus for upcoming research and observing and photographing land and water areas. In the course of the day

they will tend the plants growing in the space greenhouses. Peas, oats and onions are growing in the "Oazis" and "Vazon" units. In the "Magnitogravistat" an experiment is being performed to study the effect of a non-uniform magnetic field on development of flax seeds. Almost all planned operations with "Progress-15" have been completed. Water has been pumped into the station's tanks by the "Rodnik" system; the tanks of the unified engine system have been completely refilled with fuel and oxidizer. An orbital correction has been performed using the engine of the "Progress-15" craft. Orbital parameters following the correction maneuver are: apogee, 379 km; perigee, 312 km; period of revolution, 91.2 minutes; inclination, 51.6 degrees. (Moscow PRAVDA in Russian 29 Sep 82 p 1)

1 Oct

Cosmonauts Berezovoy and Lebedev are beginning their 21st week aboard "Salyut-7". The cosmonauts have completed the latest cycle of geophysical studies, including visual observations, photo surveys and spectrometry of the earth's surface. They have also begun experiments with the "Yelena" small-scale gamma telescope to measure flows of gamma radiation and charged particles in near-earth space. Today the cosmonauts are working on methods and equipment for orientation of the orbital complex. Studies using the "Astra-1" mass spectrometer are also planned. Regular medical studies are performed on the cosmonauts to determine their state of health and capacity for work. According to the results of the latest examination, the commander's pulse rate is 63 beats per minute; the flight engineer's rate is 72 beats per minute. Their arterial pressures are 130 over 60 and 135 over 70 mm Hg, respectively. The cosmonauts are in good health and feel well. On 29 September another trajectory correction was performed using the engines of "Progress-15". Present orbital parameters are: apogee, 384 km; perigee, 364 km; period of revolution, 91.8 minutes; inclination, 51.6 degrees. (Moscow PRAVDA in Russian 2 Oct 82 p 1)

5 Oct

The cosmonauts have been in orbit for 145 days. The work schedule of recent days has included geophysical and biological experiments and checks of equipment and systems of the station. In preparation for astrophysical studies to be conducted jointly with ground observatories the cosmonauts yesterday conducted observations of the Crab Nebula using X-ray apparatus. A cycle of measurements of optical characteristics of the earth's atmosphere has been completed using the EFO-1 electron photometer. Plans for today include scheduled maintenance operations and measurements of micro-accelerations aboard the station. The schedule also includes physical exercises, to which much attention has been devoted throughout the long flight. In order to efficiently plan the physical load of the cosmonauts their electrocardiograms are taken periodically by means of a portable device which does not constrict their movement. The recordings are then transmitted to earth during radio communication sessions. (Moscow PRAVDA in Russian 6 Oct 82 p 1)

12 Oct

Cosmonauts Berezovoy and Lebedev are completing their fifth month in space. During this time they have carried out a wide program of research and experimentation. Important statistical material has been collected on the country's mineral resources, seasonal variability of agricultural land, biological productivity of the ocean, navigating conditions and fisheries. For example, on the basis of studies performed aboard "Salyut-7", six geological detachments are currently exploring for mineral deposits in the areas of the Caspian and Aral Seas and Lake Balkhash. Today's work schedule for the crew includes a check of the radio communication system of the station, technical and biological experiments and preparation of scientific apparatus. (Moscow PRAVDA in Russian 13 Oct 82 p 3)

14 Oct

At 1646 hours Moscow time on 14 October the "Progress-15" ship separated from the "Salyut-7"--"Soyuz T-7" complex. The process of undocking and separation of the cargo ship was monitored by specialists at the Flight Control Center and by cosmonauts Berezovoy and Lebedev. During the joint flight all planned operations with "Progress-15" were fully completed. In addition, two trajectory corrections were performed using the engines of "Progress-15". Cosmonauts Berezovoy and Lebedev are beginning their sixth months aboard the "Salyut-7" scientific station. (Moscow PRAVDA in Russian 15 Oct 82 p 1)

CSO: 1866/47-P

UDC 539.1.078

COMPUTING PRINCIPAL INSTRUMENTAL PARAMETERS OF CYLINDRICAL ELECTROSTATIC ANALYZERS FOR INVESTIGATING MAGNETOSPHERIC PLASMA

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 23, No 2, Mar-Apr 82 (manuscript received 16 Jun 80) pp 46-52

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[Abstract] A practical method for carrying out computations of the characteristics of cylindrical electrostatic analyzers having slit diaphragms at the input is presented. The method is based on the spatial representation of the transmission function of energy and angle analyzers for a narrow beam of particles in the form of a "transmission" diagram for "energy-angle" space (Paolini, Teodoris, PRIBORY DYLA NAUCHNYKH ISSLEDOVANIY, No 5, p 2, 1967; No 3, p 38, 1968). This transmission diagram is the basis for constructing an integral transmission matrix for the analyzer for a broad (irradiating the entire entrance aperture) isotropic beam. The method was used in computing the parameters for instrumentation carried aboard the "Molniya-1" and "Meteor" satellites and is applicable in a wide range of investigations. A detailed computation program is set forth using as an example an analyzer having a collimator in the form of a rectangular slit with a width of 1 mm and a length of 10 mm; the output diaphragm was a rectangular slot in a thin plate measuring 10 x 1 mm. The corresponding transmission matrix is represented in a table. In this table the sum of the "energy" columns gives the analyzer energy transmission function for a wide isotropic beam. The sum of the "angles" lines gives the angle transmission function for an isotropic beam of particles with a plane spectrum. A figure gives the analyzer transmission curves for a wide beam of electrons in the region 1 KeV obtained from this matrix. Figures 3, tables 1; references: 9 Russian.
[91-5303]

GRAVITATIONAL WAVES FROM SPACE

Moscow ZEMLYA I VSELENNAYA in Russian No 6, Nov-Dec 81 pp 28-32

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[Abstract] Many years have passed since their prediction, but gravitational waves from space are yet to be detected. It is now known that the response of instrumentation for detecting these waves must be a million times greater than was believed necessary. According to theory, gravitational waves are generated by massive objects but upon their departure exist independently. They carry energy and momentum which could be detected with proper instruments. This article reviews the attempts which have been made to register these waves and proposals for improved instruments which theory suggests should be adequate for this purpose. It seems clear that an antenna with a long base, of the interferometer type, must be created. One of the fundamental concepts which must evidently be applied in designing such a detector is that of multiple scattering. By applying this method an interferometer with a base of 10 m could be made equivalent to an instrument with a base of 100 km. Gravitational antennas of such a type are now being created in the United States, England and West Germany. Other, still more radical solutions of the problem may be possible. For example, in the United States specialists at the National Bureau of Standards have proposed that antennas with a laser interferometer be launched into space; such an antenna could be formed by two or more close satellites. But there are also natural objects which could be detectors of gravitational waves and it is being proposed that these somehow be used. Joint Soviet-American investigations, on the other hand, have considerably clarified the real possibilities of detection of gravitational waves by satellite-satellite or earth-satellite systems. A Doppler space antenna might make this realistic. It is postulated that the first experimental evaluations of the upper limit of intensity of long-wave gravitational bursts could be obtained by tracking space probes making flights around distant planets. Figures 4.
[60-5303]

UDC 523.152.3:534.222.2

APPEARANCE NEAR EARTH OF INTERPLANETARY SHOCK WAVES FROM NEAR-ZONE FLARE SERIES OF 1957-1978

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 16, No 1, Jan-Mar 82 (manuscript received 22 Dec 80) pp 46-53

MIKERINA, N. V. and IVANOV, K. G., Institute of Terrestrial Magnetism, the Ionosphere and Radio Wave Propagation, USSR Academy of Sciences

[Abstract] Using data on 10 flare series that occurred between 1957 and 1978, the authors attempt to find some correlation between them and the appearance (or absence) of shock waves as a consequence of them. After categorizing the flare series as doublets, triplets or quartets and analyzing them from the viewpoint of magneto-hydrodynamics, they hypothesize that shock waves are either heavily damped or completely suppressed as the result of their interaction in the corresponding complex interplanetary flows. Figures 8; references 11: 8 Russian, 3 Western.

UDC 523.98

ONE METHOD FOR PREDICTING WOLF NUMBERS

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 16, No 1, Jan-Mar 82
(manuscript received 21 Jan 81) pp 54-59

MANDZHOS, A. V., TEL'NYUK-ADAMCHUK, V. V. and SHAYDO, A. N., Astronomical Observatory, Kiev State University

[Abstract] The authors analyze P. R. Romanchuk's method of resonance curves for predicting sunspot formation activity. This method is based on the hypothesis that the planets exert a tidal effect on the Sun. Romanchuk used information on the last 19 solar activity cycles (1755-1956) and found several inexplicable anomalies. The authors extend their analysis back to 1543 and conclude that his basic hypothesis is incorrect. Figures 6; references 25: 16 Russian, 9 Western.
[88-11746]

INTERPLANETARY SCIENCES

TELEVISION ON VENUS

Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 82 pp 4-6

[Article by Doctor of Technical Sciences A.S. Selivanov and Candidate of Technical Sciences M.K. Narayeva]

[Text] Landing vehicles from the "Venera-13" and "Venera-14" stations made a soft landing on Venus on 1 and 5 March 1982, and sent black and white and color "portraits" of Venus back to Earth.

We obtain most of our information about the environment visually. The importance of visual observations in understanding the Universe and the Earth cannot be overestimated. Even though other facilities and methods are available, scientists give precedence to the eye - a unique research instrument.

We still cannot see other planets directly, and therefore make use of space technology, and specifically the new scientific-technical area of space television.

When a person finds himself in an unfamiliar place, the first thing he does is look around. The television cameras carried aboard space landing vehicles also make a circular or fairly wide panoramic scan of the surface near the landing point. These panoramic pictures can create a definite feeling of "being there".

The first panoramic pictures from another heavenly body - the moon - were obtained in 1966 by the Soviet "Luna-9" automatic station. Since that time many newspapers, journals and television screens have carried panoramic pictures transmitted by space television systems.

The operating principle and design features of space television equipment designed for planetary research differ from those employed in broadcast television. This is because of the different, and far more difficult, operating conditions, as well as the much slower rates - by factors of thousands - at which television information is sent over interplanetary distances. These distances are measured in tens and hundreds of millions of kilometers.

The transmitting television cameras carried aboard the landing vehicles are not simply electronic devices, but employ optics and mechanics to a substantial

extent. High-precision movements of optical assemblies make a sequential (point by point) "examination" of the surrounding area. A light beam which is proportional to the brightness of each point is received through the optical system of the camera by a light-sensitive receiver which converts it to an electrical signal which is then input to a radio transmitter. In slow transmission of pictures of stationary objects, optomechanical television cameras provide information which is high in quality and more reliable from a scientific viewpoint. These devices are capable of precise measurement of light flux (this is why they are often called telephotometers). They operate more stably under difficult temperature conditions and are resistant to severe mechanical shock; they are also light in weight and small.

"Venera" space vehicles, which reached the surface of the planet more than once, provided pictures for the first time in 1975. The pictures transmitted by the "Venera-9" and "Venera-10" stations changed our conceptions about this planet in many respects and, in conjunction with other new information, provided the impetus for further development of the theory of the origin and development of the planet.

Scientists already knew about the unusual conditions on the surface (the temperature of about 500°C and pressure near 100 atmospheres created by the gaseous carbon dioxide envelope of Venus). But what was the surface like, and could anything be seen there? These questions bothered the television equipment designers. Without even an approximate answer to them, no devices could be developed. And there was no answer or, more accurately, there were many alternatives based on completely rational assumptions according to which the surface might be solid or liquid, rough or completely smooth, without contrast; the surface illumination varied from complete darkness to levels acceptable for good image transmission. It was necessary to take a calculated risk, discarding the extreme alternatives and expanding the basic capabilities of the equipment and its operating limits as much as possible.

The telephotometers were placed in a sealed compartment under slight pressure and at moderate temperature; the only part of the camera which was subjected to temperatures near those on Venus was the part which projected near the illuminator and through which the surface is observed. A reliable camera design required original technical treatments and extensive trials on the ground.

Two telephotometers were installed on opposite sides of the landing vehicle which together provided a near 360° view of the landing location. The viewing angle of each telephotometer is about 180° x 37°. The telephotometers are tilted at an angle of 50° to the vertical axis of the equipment, so that the surface immediately adjacent to the landing vehicle could be seen in the best detail in the center of the panorama and so that the microstructure of the soil and the way in which it interacts with the construction of the landing device could be evaluated. At the same time, more distant objects could be seen on the edges of the panorama, including the local horizon and parts of the sky.

The television cameras carried aboard the "Venera-13" and "Venera-14" were improved significantly based on the experience from 1975.

The resolution of the cameras, i.e., the ability to distinguish fine surface details, was doubled, comprising several millimeters on the front plane of the panorama. The panorama is transmitted in vertical steps, with 1,000 strips in each panorama. The number of half-tones contained in a picture was increased significantly. The amount of time required to send one panorama was cut in half (to 14 minutes).

In order to do all this, it was necessary to multiply the data transmission rate from the landing vehicle by a factor of 12. New methods were required for receiving and processing the signals. As the reader is probably aware, the information from the landing vehicles was relayed to the earth through station compartments orbiting near the planet which were equipped with directional antennas and provide significantly better signal transmission efficiency.

The radio technical complex at the Deep Space Communications Center in the Crimea, which has a radiotelescope with a 70-meter dish, played an important role in providing reliable reception of the relayed signal.

This facility made it possible to expand the missions carried out with the television cameras and to try to obtain color pictures of the surface. In order to do this, switchable red, green and blue light filters were built into the camera. A color picture can be synthesized by adding signals together in the proper proportions from three panoramas obtained with each of the filters. This, of course, triples the transmission time for a complete color panorama. There was some danger in this, since the duration of stable communications with the landing vehicle is a function of a number of factors involved in the flight and landing of the complex space system. The panoramas were transmitted in the following order: both cameras aboard each station first transmitted an ordinary black and white panorama for 14 minutes. The cameras then switched modes. One of them transmitted only one-third of the panorama with three light filters (short program). The other camera looked at the entire panorama through the filters three more times (complete program, taking a total of about an hour). Since the communication time exceeded the calculated time significantly, it was possible to utilize the planned time and then some. The pictures obtained are of good quality, mainly because of the quality of the initial information sent from the landing vehicle. Even so, all of the panoramas undergo lengthy computer processing on the ground. This image processing removes extraneous information from the pictures, such as inserted telemetry information transmitted in conjunction with the television signal, which show up as separate strips on the image, and pulsed noise; the brightness of the pictures is equalized in order to make photographic and polygraphic printing easier; fine details are also emphasized.

Color image synthesis also requires special processing and careful allowance for all of the components of the television signal.

A great many details can be seen on the panoramas. Some of these belong to the surface of the planet Venus, while others were "carried" from the earth. At the bottom can be seen the edge of the landing platform of the vehicle, rimmed with a toothed crown - the aerodynamic stabilizer. The ladderlike

construction on the ground (on the left) is an instrument which measures the physical and mechanical properties of the soil. The bright detail in the center is the lid which covers the telephotometer illuminator during landing and which is discarded after landing. The collection of rectangular plates on the right is a color test pattern which is used, in conjunction with other methods, to control color image synthesis (cf. inside back cover and color insert - Ed.).

The soil is different at the landing location of the "Venera-13" and "Venera-14" stations. The first of these has more bright formations, and the rocks stand out against the background of relatively dark, disturbed soil. The landing point of the second station is more rocky and fissured. On the whole, the measurements indicated that the surface of Venus is dark, with a coefficient of reflection of about 10%.

The color image synthesis, even though it is preliminary, and we might say "rough", provided a great deal of interesting information. The first thing to be pointed out is the insignificant signal in the blue region of the spectrum. It was expected that this region of solar radiation would be suppressed in Venus' thick atmosphere, but not to this extent: this requires special analysis and explanation. The color image was therefore synthesized from only two primary colors - green and red - which depletes somewhat the palette of Venusian colors, but provides objective evidence of what a person riding in the landing vehicle would see. The sky on Venus is yellow, and its color and brightness apparently varies from the horizon to the zenith. The color of the sky can be seen in the upper corners of the panoramas, and it also shows up in the light of the elements of the landing platform and near the cover of the illuminator.

The dark rocks on the panorama sent by "Venera-13" are greenish-brown in color. The surface around the "Venera-14" station is reddish. Both panoramas demonstrate a slight relationship between color shades and the angle of observation.

The color image synthesis will continue, and we can expect some refinement of the color shading. It will be interesting to extract the third color component - blue (or blue-green) from the black-white panorama, which contains the sum of all three colors taken in a defined proportion. If this is successful, a way will be provided for reproducing color panoramas which would look as if they were viewed under illumination conditions on the earth.

Analysis of the panoramas obtained is an effective method of studying the structure of Venus' surface. In combination with other instruments carried aboard the landing vehicle, such as the soil chemical composition and density measuring devices, better estimates can be obtained of the measurement accuracy and the possibility of extending them to adjacent areas and other regions on the planet.

The panorama of Venus, chemical analysis of the substance of the planet and other scientific information are the end result of many years of work on the part of large collectives of scientists, designers and workers.

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UNIFIED THEORY OF MOTION OF INNER PLANETS

Moscow IZVESTIYA in Russian 1 May 82 p 3

[Article by V. Kotel'nikov, academician, and M. Kislik, professor: "Getting to Know the Universe"]

[Text] Soviet scientists have developed a highly accurate, unified theory of motion for the Solar System's inner planets (Mercury, Venus, the Earth, Mars). In addition to its great general scientific value, it is also of great practical importance and is being used in the solution of various problems of interplanetary cosmonautics.

The creation of theories of motion for the bodies in the Solar System is a basic and extremely old problem of theoretical astronomy. In the terminology used in astronomy, the theories of motion of the heavenly bodies are mathematical relationships that make it possible, at any given moment, to compute (in the coordinate system that has been selected) the positions of these bodies (the planets, their natural satellites, asteroids, comets).

The first theories of motion of Mercury, Venus and Mars that were of practical value were developed in a geometrical version--that is, with an immobile Earth at the "center of the world"--in the 2nd Century A.D. No one succeeded in improving these theories substantially for the next 1,500 years. At the beginning of the 17th Century, Kepler (who was developing Copernicus's ideas) placed the Sun at the "center of the world" and discovered the basic laws governing the heliocentric motion of the planets. These laws were both simple and elegant, and Kepler's work completed the initial stage of the investigation of the Solar System's kinematics.

Newton's discovery of the Law of Universal Gravitation and his development of mathematics raised theoretical astronomically to a fundamentally new level. The mathematical model of the Solar System was based on the dynamic equations of motion of the heavenly bodies. Using the available observational materials in an exhaustive fashion, Leverrier and then Newcomb developed gravitational theories of motion for the inner planets at the beginning of the 19th Century. The refinement of these theories in the present century resulted in a situation where discrepancies between the theoretical and experimental data remained only in the secular (that is, proportional) times of displacement of the planetary orbits' perihelia (perihelion is the point in a planet's orbit when it is closest to the Sun). Allowing for one of the effects of Einstein's General Theory of Relativity that explains these discrepancies

resulted in an almost complete agreement between the theories of motion and observational data.

Let us mention, however, the following essential facts. The only experimental basis for the construction of the classical theories was measurements of the angular coordinates of the Sun and the planets that were made with terrestrial optical equipment. The maximum discrepancies between the theories and the observations were, as a rule, 2-3 angular seconds, which corresponded to the measurement errors. Consequently, at distances of 100-200 million kilometers, the errors in determining the planets' positions in the direction perpendicular to the line of sight reached 1,000-3,000 kilometers. The unit of length used was the average distance from the Earth to the Sun (the "astronomical unit"). Until 1961 its value was known (as was later discovered) with an error of about 70,000 kilometers. However, since astronomers had at their disposal only terrestrial optical equipment, even such a large error had practically no effect, either on the construction of theories of planetary motion or on these theories' utilization.

Interplanetary flights and radar observations of the planets began in 1961. There was a sudden and radical change in the study of the Solar System. A new stage in the development of theoretical astronomy began, based primarily on the extensive use of these observations.

The continually increasing accuracy of these observations resulted in a situation where, after several years, the maximum error in measuring the distances between the Earth and the nearest planets was, as a rule, only 1-3 kilometers, which is less than the equivalent error of optical observations by a factor of 1,000. There was an almost immediate experimental revelation of the unsoundness of our knowledge of the Solar System's actual dimensions and the significant errors in the classical theories, which in a number of cases reach 1,000-1,500 kilometers.

First of all, the radar observations led to a cardinal refinement of the size of the astronomical unit. Then, on the basis of radar observations in combination with optical observations and observations of the motion of automatic interplanetary stations, special theories of motion that were substantially more accurate than the classical ones were developed in a Newtonian variant for Venus, the Earth and Mars. After accumulating the necessary volume of original measurement information, Soviet scientists set about creating a unified theory of motion for the Solar System's inner planets. In connection with this it proved necessary to change over from Newtonian to relativistic celestial mechanics and to make full use of the laws of Einstein's General Theory of Relativity.

In view of the great scientific and practical importance of this work, it was split up among three collectives, all of which are subordinate to the USSR Academy of Sciences: the Institute of Applied Mathematics imeni M.V. Keldysh, the Institute of Radio Engineering and Electronics (in conjunction with a number of other organizations) and the Institute of Theoretical Astronomy. All three collectives worked independently, collating their results on a stage-by-stage basis.

In order to describe the motion of the planets, a new and highly accurate method for the numerical integration of equations of motion was worked out in detail and first used in practice for the solution of problems in theoretical astronomy. For the combined processing of large masses of measurement information of different types,

a technique was developed that makes it possible to do this processing with computers in a short period of time. In connection with this, there was provided the possibility of determining not only the elements of the orbits of all the inner planets, but also a number of fundamental astronomical constants: the planets' radii and the astronomical unit. In order to increase the accuracy of the matching of the theoretical and experimental data, information on the relief of Venus and Mars was also used during the processing of the radar observations.

The concept of the comparison of theoretical and experimental data was first clearly formulated, confirmed by numerous examples, and proven in relativistic celestial mechanics. This concept was tested experimentally on a large mass of factual material. As a result, we have created a reliable basis for the practical use of the General Theory of Relativity in celestial mechanics.

In each of the three collectives named above, a complex of algorithms and programs for constructing highly accurate theories of motion of the inner planets was created on the basis of observational data. The complex is a quite general-purpose one. With small changes it can be used to formulate theories of motion for the outer planets, the asteroids and comets.

The initial measurement information used in the construction of a unified, relativistic theory of motion for the inner planets consisted of radar observations of Venus, Mars and Mercury made in the USSR (1962-1980) and the United States (1964-1971), optical observations made at the Nikolayev, Washington and Greenwich observatories, and observations of the motion of the "Venera-9, -10, -11, -12" stations. In all, more than 13,000 measurements were processed. The entire set of measurements was used simultaneously to determine the values of the elements of the orbits of Mercury, Venus and Mars, as well as the center of mass of the Earth-Moon system, the radii of Mercury and Venus, the equatorial radius of Mars and the astronomical unit.

The matching of the formulated theory and the observations is characterized by the following data. In all sections of the 20-year measuring interval, there are practically no systematic deviations. The root-mean-square deviations of the radar distances, beginning with the years 1967-1970, are 0.9 kilometers for Venus, 2 kilometers for Mercury and 2.5 kilometers for Mars. Allowing for relief reduces these deviations to 0.5 kilometers for Venus and 1 kilometer for Mars.

Tables of the planets' positions were compiled in a form suitable for immediate use so that the theory that was created could see extensive practical realization.

The match achieved between the experimental and theoretical data is an experimental check of the General Theory of Relativity by astronomical methods, and it is a check of a global nature; that is, it encompasses all possible effects in the motion of The planets and the propagation of light.

The radar ranging of Venus that was done in the Soviet Union from December 1981 to February 1982 also confirmed the high accuracy of the unified, relativistic theory of motion of the inner planets. At this time Venus was 40-58 million kilometers away from the Earth. The discrepancy between the predicted and measured values of the radar ranging did not exceed 1.2 kilometers.

In conclusion we should mention that the further development of the experimental base of theoretical astronomy, primarily on the basis of the radar ranging of heavenly bodies and interplanetary cosmonautics, must undoubtedly result in new and fundamental results in the field of investigating the dynamics of the Solar System.

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COLOR DIFFERENCES AND CHEMICAL ELEMENT CONTENT OF LUNAR SURFACE SOILS

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 16, No 2, Apr-Jun 82
(manuscript received 24 Apr 79) pp 69-76

SHKURATOV, Yu. G., Astronomical Observatory, Khar'kov State University imeni
A. M. Gor'kiy

[Abstract] Using data available in the literature, the author asserts that the iron and titanium content of lunar surface soil is the primary determinant of the soil's color in the visible, near-infrared and near-ultraviolt bands of the spectrum. He then attempts to set up a mechanism to solve the inverse problem; i.e., determining iron and titanium content from soil color. He concludes that his method is valid only for mature "marine" soil with high iron and titanium contents. Figures 3; references 41: 16 Russian, 25 Western.
[103-11746]

UDC 523.34:528.913

EXPERIMENT IN COLORIMETRIC MAPPING OF LUNAR SURFACE IN 0.62-0.95 μm SPECTRAL BAND

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 16, No 2, Apr-Jun 82
(manuscript received 16 May 79, after revision 10 Feb 82) pp 77-85

YEVSYUKOV, N. N. and SHESTOPALOV, D. I., Khar'kov State University imeni
A. M. Gor'kiy

[Abstract] The high degree of regularity of lunar spectral reflection curves in the 0.3-1.1 μm band opens the possibility of giving a simple colorimetric description of them for the purpose of mapping the entire lunar disk. After giving a detailed description of the photographs, equipment and materials used to compile the colorimetric map, the authors conclude that their quality depends more on the quality of the original photographic material than on the processing methods. Figures 4; references 19: 12 Russian, 7 Western.
[103-11746]

UDC 523.34:523.031

COVARIANCE ANALYSIS OF INTERRELATIONSHIP OF LUNAR RELIEF AND GRAVITATIONAL ACCELERATION

Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 16, No 2, Apr-Jun 82 (manuscript received 14 Nov 80) pp 87-92

SANOVICH, A. N. and TADZHIDINOV, Kh. G., State Astronomical Institute imeni P. K. Shternberg

[Abstract] Using gravimetric maps of radial acceleration lines based on Doppler measurements made from the command and service modules of "Apollo-15, -16, -17," as well as height profiles of the lunar surface compiled from laser altimeter measurements made by the same spacecraft, the authors construct the covariance functions for lunar relief and gravitational acceleration and then analyze them. After deriving the cross-correlation functions for gravitational acceleration and relief, they conclude that there is only a slight linear relationship between gravitational field anomalies and relief, as is the case with the Earth. Because of the possibility of drawing analogies, this may be of use in further studies of our planet and its satellite. Figures 7; refereneces 10: 3 Russian, 7 Western.
[103-11746]

LIFE SCIENCES

NEW PLANT-GROWING EXPERIMENTS ON 'SALYUT-7'

Moscow IZVESTIYA in Russian 17 Jun 82 p 6

[Article by B. Konovalov, special correspondent: "The 'Salyut' Greenhouse"]

[Text] Today's cosmonaut must be, as they say, a "jack-of-all-trades" in order to carry out experiments in the most variegated scientific fields. However, in the series of technical and scientific experiments that Anatoliy Berezovoy and Valentin Lebedev are now conducting on board the "Salyut-7," there are some that evoke special and personal feelings from the "El'brus" crew.

"It catches your eye how that pea waves around--it's already 30 centimeters long," they say as they proudly show their families one of the "beds" in their space garden during a television conversation on their day off.

"It already leans against the lamp, and it can bend. The tendrils are large," says Lebedev to his wife, knowing quite well that this is a very pleasant novelty for her. Lyudmila Vital'yevna is a member of the scientific collective that prepared the program of biological experiments. Therefore, when working in their own space garden, the "El'brus" men are not only raising vegetables, which are desirable things for any cosmonaut, but are also trying to remember their relatives and people close to them. One can be quite certain that the beds on the "Salyut-7" are not left unwatered.

This is not the first time V. Lebedev has conducted biological experiments in space. When he and P. Klimuk were working in "Soyuz-13," they tested in space the "Oazis-2" biological system, which was used to investigate the possibility of using microorganisms in prospective life support systems.

Now, on his second flight into space, V. Lebedev--together with A. Berezovoy--is testing the "Oazis-1A" system with higher plants. The "El'brus" crew is continuing experiments that were begun as long ago as the first "Salyut" station.

It should be mentioned that the higher plants presented the space biologists with a surprise. They sprout quite well, turn toward the light, produce foliage and even flower, but do not form seeds. Not one of the higher plants has yet gone through a complete development cycle in space. There are two competing viewpoints on the cause of this phenomenon. Some people think that there is apparently some fundamental barrier for the development of higher plants in weightlessness. Others assume that it is simply a matter of technology, that the scientists and designers have not

yet learned how to create those conditions that plants need for normal development in space.

The investigators have to test both of these hypotheses. Therefore, the design of the "Oazis" equipment--compact space greenhouses in which plants are grown in orbit--is constantly being improved.

On "Salyut-7," as before, the plants are developing in artificial soil, but in contrast to the previous experiments, in the new "Oazis" units it is possible to ventilate the plants' roots, meter the moisture supplied them minutely, and create in the soil an electrostatic field that simulates terrestrial conditions. In another unit it is possible to investigate quite precisely the effect of our planet's changed (in comparison with ground conditions) magnetic field. Later on the cosmonauts will begin an experiment to grow plants in a unit with an atmosphere that is isolated from the air in "Salyut." The search is covering a broad front. The scientists want to find that link in the chain of space conditions that interferes with the normal growth of the higher plants.

In the Flight Control Center on 15 June, journalists met with two representatives of the large collective of scientists and institutions that has been conducting space research in problems of space biology for a long time: A. Skladnev, director of the All-Union Scientific Research Biotechnical Institute of the Main Administration of the Microbiological Industry, and A. Mashinskiy, the chief of this institute's laboratory.

In their opinion, even if it turns out that the higher plants cannot produce seeds in space, this will not interfere with the creation of large space greenhouses when the practical need for them arises in the future. After all, seeds do not weigh very much and they can be shipped from Earth or the necessary supply can be taken along if a spacecraft is sent into the depths of the Solar System at some future date. A more important goal from this point of view is to learn how to use free sunlight instead of artificial light, as is done now. The greenhouses can then be bigger and will become true "gardens" for cosmonauts.

"Research in the field of space biology has not only scientific, but also practical, value," says Anatoliy Aleksandrovich Skladnev. In Belorussia, for example, artificial soils and the space technology for growing plants have been used successfully in floriculture, in order to eliminate manual labor by eliminating weeding, thereby putting production on an industrial basis. Artificial soils are still expensive for normal greenhouses, but this situation will change with the development of research to improve them and the enlargement of the scales of production."

In weightlessness in the future, along with the production of new materials on board orbital stations, it will be also be possible to create technological installations for the microbiological synthesis of some valuable substances, such as rare enzymes that are now used in medicine to cure various diseases. On Earth it is either extremely expensive to produce them or it is generally impossible because of the fact that it is not possible to achieve the necessary purity of the product, which means that side effects cannot be eliminated.

While we were talking with the scientists, the voices of the "El'brus" men could be heard over the Flight Control Center's dynamic speakers. Normal business

conversations were being carried on with the cosmonauts. No one was bored during this, because they were not only carrying out the current scientific experiments, but were also preparing for the upcoming ones. The future is being put together today. Some day the crews of 100-man orbital stations, strolling through their space flower and vegetable gardens, will recall with gratitude the efforts of our era's cosmonauts.

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FURTHER COMMENTARY ON BOTANICAL EXPERIMENTS ON 'SALYUT-7'

Moscow PRAVDA in Russian 17 Jun 82 p 3

[Article by A. Pokrovskiy, special correspondent: "Orchids on Earth and in Space"]

[Text] These days on the "Salyut-7" station, Valentin Lebedev frequently recalls his first voyage in the "Soyuz-13" ship 9 years ago. There were many grounds for comparison. In particular, at that time he first participated in the original biological experiments in space: using an "Oazis-2" unit, the vital activities of micro-organisms in weightlessness were investigated. In the station now, however, there are a whole series of biological installations for various purposes.

"What caused this?" asks A. Skladnev, director of the All-Union Scientific Research Biotechnical Institute of the Main Administration of the Microbiological Industry. Two basic directions for biological experiments in space have now been clearly defined: determining the special features of the development of living organisms under these unusual conditions and searching for ways to make practical use of plants and micro-organisms in a near-Earth orbit.

As far as the simplest organisms are concerned, much that has occurred proved to be comparatively simple. Bacteria with a short life cycle completed it completely satisfactorily in orbit and, in addition, demonstrated a number of special features that are favorable for practical utilization.

For example, micro-organisms in weightlessness react more acutely than on Earth to both favorable and negative developmental factors. Thus, there is the possibility of directed effects on their vital activities. The fruits of this activity can be such extremely valuable substances as enzymes that are extremely expensive to produce on Earth.

However, is everything absolutely clear about the behavior of the simplest organisms in space? A. Skladnev says no. For example, in micro-organisms in weightlessness there appear so-called electron-packed zones that cannot be seen with an electron microscope. The reason for this is still not understood. However, the higher plants raise even more questions for the scientists. The main one is: why do they not complete their life cycle in space and produce seeds?

"Do you remember this photograph?" asks the institute's laboratory chief, A. Mashinskiy, who is one of the pioneers in formulating biological research in space. "These really beautiful orchids were sent to 'Salyut-6' in a 'Malakhit' unit.

V. Ryumin mentioned at the time that the orchids' systems of air roots were beginning to develop more energetically than they did on Earth. Then the flowers began to drop on the fifth day. These plants were later returned to Earth, and we now have them in our laboratory. They grow well, but they no longer flower..."

What is going on here? It is possible that some laws for the development of plants in space that are as yet unknown to us are in operation, and also possible that they merely lack some conditions or other for flowering. Specialists have created installations that make it possible to stimulate the root system electrically, meter the water supply more accurately, and even act on plants with magnetic fields. It is to the point here to mention that scientists at the USSR Academy of Sciences' Institute of Chemical Physics have told the biologists that seeds in a magnetogravistat put out rootlets oriented in the directions of the magnetic force fields. This observation is an extremely interesting one, so now Valentin Lebedev has yet another "Oazis-1A" unit to deal with. And what can now be said about the results?

"We need a combine up here to harvest our crop," jokingly complain Anatoliy Berezovoy and Valentin Lebedev as they showed their "vegetable garden" to the biologists. As a matter of fact, on "Salyut-7" a pea grew to almost 40 centimeters, although in a terrestrial control experiment its height was only 25 centimeters. In a "Vazon" unit that was used especially to deliver bulbous plants into orbit, a green onion is growing.

However, even by "eyeballing" the specialists have already determined that there are several peculiarities in the development of the plants. For example, the pea--a plant that on Earth seeks support so that it can grow upward--keeps to the direction toward the light source in space. On the other hand, the scapes of the green onion bent downward, as if they were the top of a palm tree. All of these special features are being recorded continuously by a moving picture camera.

Nevertheless, space biotechnology has begun to work directly for terrestrial needs. Artificial soil made from ion-exchange resins has begun to be used more widely in floriculture, because in this "soil" there are no weeds, and it is easy to select its mineral content for any type of flower. As experiments in Belorussia have shown, this is an economically profitable affair.

Here we have seen yet more evidence of the terrestrial "profile" of cosmonautics.

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'FRAGMENT' SPACE SYSTEM FOR NATURAL RESOURCE STUDY

Moscow ZEMLYA I VSELENNAYA in Russian No 4, Jul-Aug 82 pp 6-12

[Article by Candidate of Technical Sciences G.A. Avanesov and Candidate of Technical Sciences Ya.L. Ziman]

[Text] The "Fragment" equipment, carried aboard the "Meteor" satellite, has been developed for timely investigation of the Earth's natural resources in the optical waveband. The orbit of the satellite, approximately 650 km high, allows the same areas on the ground to be seen at the same time of day once every 15 days.

Investigation of the Earth from space at first gave rise to some lack of confidence. After all, it would seem to be simpler and cheaper to study mineral resources, water, forests and agricultural crops from the ground. However, there is no doubt today about the effectiveness of studying the Earth's natural resources from orbital altitudes. There are many reasons for this, most important of which are enumerated below.

It is becoming increasingly important to discover natural resources, estimate their reserves and evaluate the possibility for preserving and renewing them. It has become necessary to protect the environment. The shortage of many minerals, primarily oil, requires that new deposits be found. The limited nature of the mineral resources in regions which have been exploited for a long time forces us to investigate inaccessible regions. It is necessary to "see" the deep-lying deposits which are difficult to detect using traditional geological prospecting methods.

The requirements which have built up have made obvious the incompleteness of information and insufficient timeliness of existing facilities for providing information on crop growth, forest conditions, floods, forest fires, volcanic eruptions and other phenomena.

The combination of the heightened requirements and new technical capabilities provided by space facilities has brought about the birth and intensive development of investigations of the Earth from space.

At first, the development of this research borrowed aerial methods; however,

aerial imagery is interpreted by specialists directly on the spot, which cannot be done for space imagery. The areas on the ground which are photographed from space are thousands, and sometimes tens of thousands, times greater than those which can be covered in the same amount of time from an aircraft. As an example, one picture from the orbiting "Salyut" station covers a 240 x 175 km area on the ground, and in ten minutes of photography can image over one million square kilometers. An aircraft could photograph an area more than 1000 times smaller in the same amount of time.

The devices most commonly used are those which allow the Earth to be "looked at" from orbital altitudes in the visible and near-infrared regions of the spectrum. These are photographic, television and spectrometric systems. Most of these were borrowed from aviation; however, as is often the case, when space research borrows familiar methods and facilities it changes them significantly, adds a great deal which is new and raises the facilities to a completely different level of technical sophistication. This was the case in the area of remote base methods for measuring and monitoring the natural resources on the Earth.

Imaging Equipment

The multizonal method was developed, and imaging equipment was created. In the multizonal method, a section on the ground is imaged in several spectral zones at the same time.

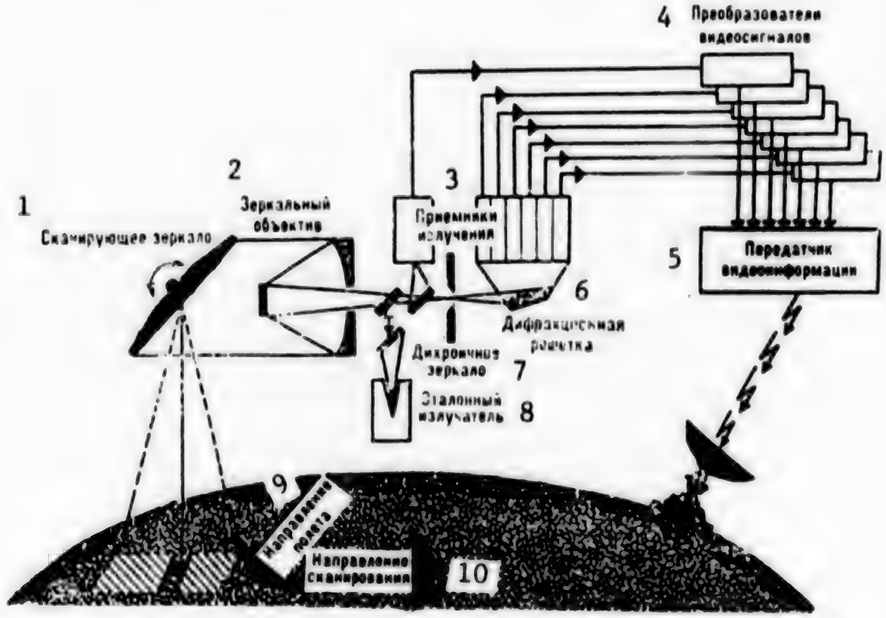
The simplest type of equipment for multizonal imagery of the ground is multizonal photographic equipment (ZEMLYA I VSELENNAYA, 1977, No. 2, p. 10-15). These are units of several identical photographic cameras which operate synchronously with the optical axes of their lenses parallel to one another. The only difference is that the cameras are equipped with different light filters and are loaded with film having different spectral sensitivity.

Multizonal optical-mechanical scanning systems represent a more complicated type of equipment. The information generated by scanning systems is sent by radio to the Earth and can be processed in real time, i.e., practically simultaneously with the scan. The devices which receive the radiation in scanning systems are photomultipliers or solid-state detectors. These receivers make imagery possible over a wide range of electromagnetic waves, and the information generated is characterized by high accuracy in measuring the radiation flux.

Element-by-element scanning - scanning the ground in the direction perpendicular to the ground track - is done by continuously rocking a special mirror; scanning in the direction of flight is done through the motion of the satellite itself.

The streams of radiation are spectrally divided by using filters (as is done in multizonal photographic equipment), or by dichroic mirrors, which pass part of the electromagnetic radiation up to a particular wavelength and reflect the rest of the radiation with longer wavelengths, or by prisms and diffraction

gratings, which deflect electromagnetic waves with different lengths by different amounts.



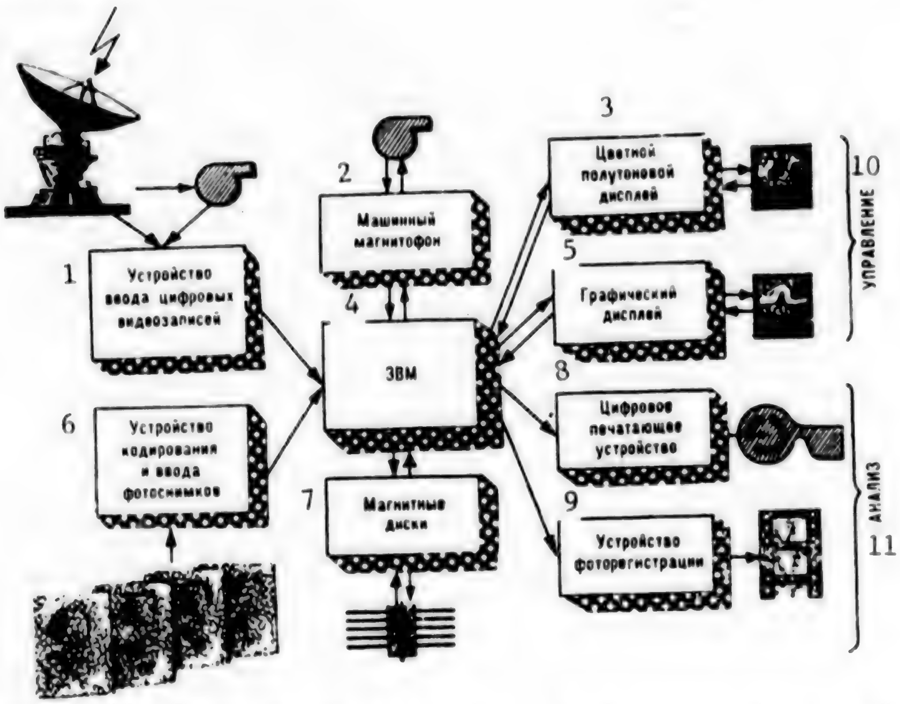
Block diagram of multispectral scanning system. Key: 1) scanning mirror; 2) mirror objective; 3) radiation receivers; 4) video signal converters; 5) video information transmitter; 6) diffraction grating; 7) dichroic mirror; 8) standard radiator; 9) direction of flight; 10) scanning direction.

Now that we have discussed the existing types of imagery equipment, we could begin to look at the "Fragment" system in detail, since it is of greatest interest today. However, in order to retain clarity and logic in the exposition, we must first direct the reader's attention to a fairly specific but exceptionally important aspect, without which the true role of "Fragment" in low-orbiting research now underway would not be made clear enough. We therefore shall now deal with a new theme.

Interpretation of Space Information

Regardless of the region (or regions) of the spectrum and types of instruments employed for imagery from space, and regardless of the form - photographic film or magnetic tape - in which the video information is recorded, the latter is first converted to photographic images of the scanned surface. At first, these images were interpreted exclusively by traditional visual and optical methods, which have recommended themselves well in investigating and mapping

the Earth's surface using aerial photography materials. The main recognition features used in these methods are the geometric characteristics of formations on the ground - the dimensions, configuration, orientation and structure. The experience of the interpreter and his familiarity with the appearance of various formations on the ground, and the processes occurring therein, are of decisive importance.



Special-purpose computer-based display complex for processing and interpreting space video information. Key: 1) digital video recording input device; 2) tape recorder; 3) half-tone color display; 4) computer; 5) graphic display; 6) photo coding and input device; 7) magnetic disks; 8) digital printer; 9) photographic recording device; 10) control; 11) analysis.

Visual-optical methods have inherent shortcomings: first of all, rapid processing of information coming from space requires a huge staff of specialists; secondly, visual-optical methods are ineffective for interpreting multizone imagery in which there is more than one image of the same area on the ground and all of the images must be analyzed at the same time; third, the accuracy with which the spectral brightnesses are measured by optical-electronic and radiometric imagery systems is wasted to a significant extent when the measurement results are represented photographically.

These shortcomings can be avoided by using a computer, and employing the ratio of the brightnesses in defined narrow zones of the spectrum - spectral "portraits" of objects on the ground - as distinguishing features. If these "portraits" are "painted" in advance and stored in a special "bank", it becomes easy to automate recognition by measured spectral brightnesses.

Even so, building up a catalogue of spectral "portraits" is more difficult than

it might seem at first glance. The spectral characteristics of formations on the ground are influenced by many internal and external factors, which are very difficult to allow for. External factors include primarily the influence of the atmosphere, changes in illumination conditions, and the relief of the area. Internal factors are of particular interest, since these include changes in the observed objects themselves caused by natural processes, as well as the influence of unforeseen natural and anthropogenic effects.

In order to single out and make allowance for all of these factors, space imagery of large territories is accompanied by synchronous imagery from planes and helicopters, and even direct investigation on the ground. The materials from these "three-story" pictures are used to define the spectral "portraits" of test areas for given specific conditions. Formations analogous to the test formations are sought on these "portraits". This approach is used today in conjunction with computers to make analysis and decoding of space imagery of the ground significantly easier.

Even so, the use of computers does not completely automate all processes involved in analyzing space video information, nor does it provide an unambiguous solution to many problems. Man's capabilities of seeing and analyzing images (detecting indirect features, isolating characteristic points, lines, boundaries, distinguishing between structures, etc.) cannot yet be duplicated by a machine, at least in terms of confidence.

In order to achieve maximum effectiveness in processing and interpreting video information from space it is necessary to combine intelligence of the interpreter and the computer's ability to analyze huge masses of data rapidly. This combination is realized most effectively in special-purpose display computer complexes which permit interactive digital processing of video information. This means that the image remains a means of communication between man and machine during all processing stages. The technician who operates this complex can obtain a picture of any processing stage on a color screen as desired. The program which processes these images can be corrected on the basis of visual analysis of intermediate results.

Machine processing of multizone space video information is more productive and clear, and reflects qualitative characteristics more extensively, than processing other types of images. Because of this, special-purpose computer complexes have appeared for processing and interpreting aerial imagery information concerning the Earth. The spectrum of problems which can be solved by these special-purpose complexes is extremely wide, including recognition of given contours on the ground, referencing the coordinates of images to a map, transforming images to any required scale and projection, increasing contrasts, isolating contours, etc. These complexes are usually equipped with two types of devices for inputting video information to the computer. One type inputs data, either from magnetic tapes prepared on high speed tape recorders at the space communications facilities or directly from a radio link; the other reads, codes and inputs individual and multizone photos to the computer. The computer usually has two types of magnetic memory - tapes and disks. Tapes are used for archive storage of large amounts of digital records. Magnetic disks are

used to store information which the computer is processing at a particular moment, allowing rapid and convenient access to any of it.

Near-Real-Time Investigation of the Earth From Space

The requirements for video information from space were studied in support of intensive scientific and practical development of implementation of methods of using space technology to investigate the Earth's natural resources. It turned out that the best way to satisfy these requirements is to have a continuously active space system for investigating natural resources which employs satellites fitted with technical equipment for remote sounding. Two ways were noted of obtaining, processing, disseminating and utilizing information from space - long-term and real-time.

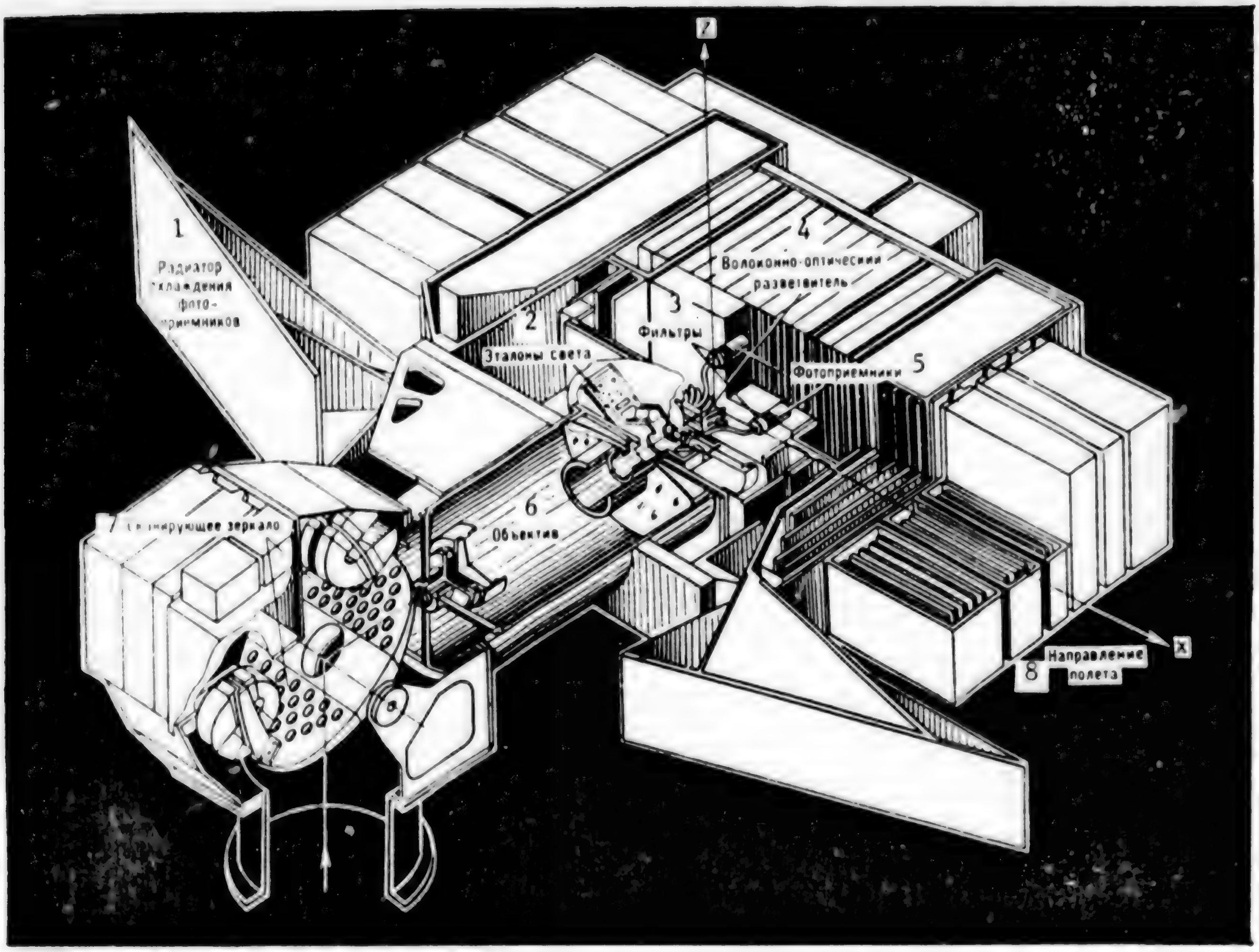
In the first of these methods, undeveloped film is returned to the ground by means of capsules which are released from the spacecraft. This method provides multizone photography of the ground with good spatial resolution, and allows the data to be used to compile and update thematic maps. This approach is important in studying the characteristics of the Earth's surface, vegatation, shelf water and other natural objects which remain essentially unchanged over long periods (months, years).

Near-real-time missions require that the time between imaging an object and delivering the data to the user be counted in days or even hours. This refers especially to information on young crops in fields. In order to obtain a quick answer, the information must be transmitted by radio from the satellite and processed immediately. This cannot be done without appropriate on-board and ground equipment, as well as computers.

Besides the on-board equipment for imaging the ground, this complex must include gear for transmitting a large stream of video information over the downlink, and for receiving, recording and quick processing of that information. Precisely such a complex has been developed for near-real-time tasks by the Institute for Space Research of the USSR Academy of Sciences in conjunction with a number of other organizations. This complex is based on a spaceborne multizone scanning system called the "Fragment". The name reflects its scientific-research nature. This system is actually not designed for global imagery. Its mission is to study the ground within a circle with a radius of about 2500 km with its center in Moscow. Of course, this can be called a "Fragment" only on a cosmic scale.

This complex has been in successful experimental operations since June 1980. The information which it has provided is measured in thousands of kilometers of magnetic tape and millions of square kilometers of imaged area. Practical experience has been gained in operating the complex, providing timely acquisition and processing of information in the interests of investigating natural resources.

The experimental information-measurement complex is made up of three systems: the "Fragment" imaging system itself, a digital transmission, reception and recording system and a digital processing system. The first of these systems -



Cutaway diagram of "Fragment" imaging system. Key: 1) photodetector cooling radiator; 2) light standards; 3) filters; 4) fiberoptic splitter; 5) photodetectors; 6) objective; 7) scanning mirror; 8) direction of flight.

"Fragment" - is a complicated optoelectronic unit weighing more than 250 kg. It combines imaging and spectrometric equipment. A wide strip on the ground is scanned by a rocking mirror. The "Fragment" is outstanding in the ground imagery detail it provides and the accuracy with which it measures spectral brightness. This makes computer processing of the video information obtained possible and efficient. Imagery is done in eight spectral zones with ground resolution of up to 80 meters. In designing the "Fragment", the designers had to resolve many complicated technical problems. To give the reader some idea of this, here is one such problem. A scanning mirror more than 30 cm in diameter was needed at orbital altitude to measure the solar radiation reflected by an 80 x 80 square meter area on the ground. This mirror is rocked by an electromagnetic drive at a rate of 13 Hz along the axis parallel to the direction of flight of the satellite, making one swing and returning to its resting position in 1/13 second. The satellite advances by about 500 meters during that amount of time. In order to provide imagery with 80-meter

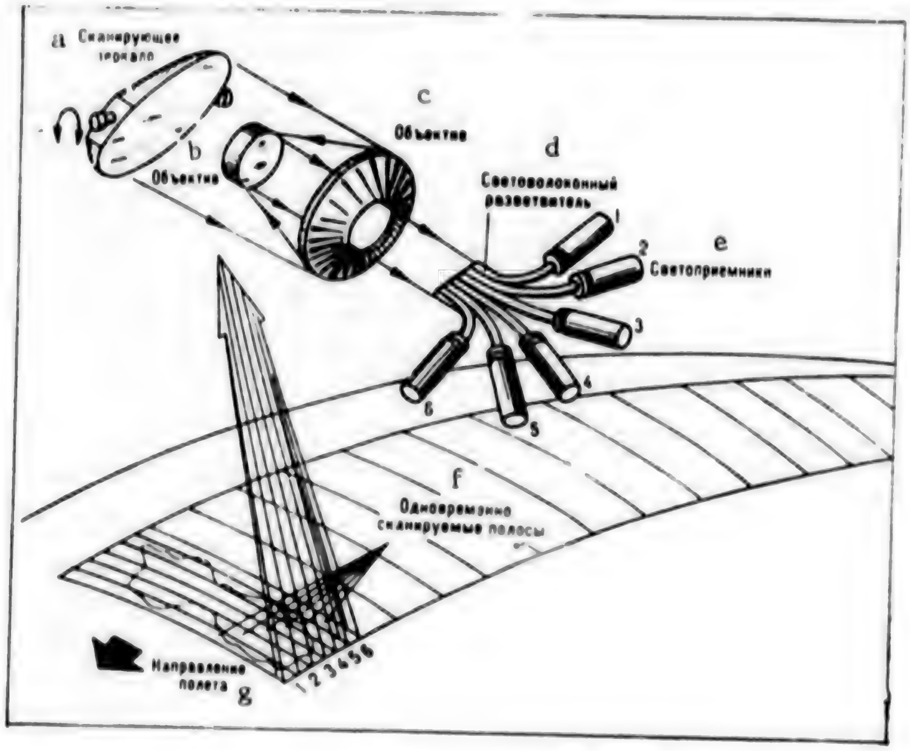
resolution in 1/13 second, it is necessary to scan six strips on the ground perpendicular to the flight path at the same time, rather than a single strip. For this reason, the focal plane of the imaging objective aboard the "Fragment" contains a fiberoptic image splitter. The six adjacent square ends of the splitter, which are arranged in the direction of flight, image the ground within one zone of the electromagnetic wave spectrum. The light from each area is sent over its own light guide to six photodetectors, all of which are fitted with identical light filters. During one swing of the mirror, this construction permits imagery in the spectral zone in question of a strip on the ground 480 meters wide (or, more accurately, six strips, each 80 meters wide).

The fiberoptic splitter has 35 light guides connected to 35 photodetectors. Thirty of these (6 x 5) provide imagery with 80-meter resolution in five short-wave zones of the spectrum - in the 0.4 - 1.1 μm band. The others (five of them) are used for imagery with lower resolution in the 1.2 - 2.4 μm wavelength band.

In developing the "Fragment", the designers concerned themselves with obtaining and transmitting the image (like in an ordinary television system), as well as precise measurement of the spectral brightnesses of each element on the imaged surface. This is because detailed computer analysis can be made on the video information when the spectral brightnesses are known precisely. Only in this way is it possible to learn in detail about the physical, chemical and biological properties of the areas imaged. In order to do this, the spectral brightnesses of the elements on the ground are converted to digital form (in binary) aboard the satellite. These are then transmitted in that form to the ground. The brightness of each element is determined according to a 256-level scale, with each level expressed as an eight-bit word in binary notation ($256 = 2^8$). When the "Fragment" is imaging with 80-meter resolution in four spectral zones at the same time, 500,000 such words, or 4 million bits of information, are formed and transmitted to the ground each second. In order to transmit this huge stream of data and to receive it and record it on the ground, the Special Design Bureau of the Moscow Power Engineering Institute developed a special digital radio link. The main advantages of digital transmission of video information are its high reliability and noise tolerance.

The information from the "Fragment" is received on the ground by a directional parabolic antenna about 25 meters in diameter. The aperture of this antenna - the angle within which it "sees" the satellite - is less than 1°. Therefore, in order to receive the transmitted video information the antenna must track the satellite to within a few arc minutes and fractions of seconds. Powerful mechanisms allow the antenna to turn with such accuracy. They do this based on the data obtained from trajectory measurements of the satellite orbit.

It is no simple matter to record information arriving at a rate of four million bits per second. Special video recorders were needed in which the recording tape speed reaches eight meters per second, while a rate 30 times smaller is needed for inputting the video information to the computer. It is therefore necessary to re-record the original tape twice at lower speed. After this procedure, which is done at the point at which the information is received, the



Simultaneous six-strip scanning of ground in same spectral zone by "Fragment" system. Key: a) scanning mirror; b) objective; c) objective; d) fiberoptic splitter; e) photodetectors; f) simultaneously scanned strips; g) direction of flight.

magnetic tapes containing a recording which can be input to the computer are delivered to a special-purpose digital video information processing display system. It is here that the information undergoes complex processing.

The "Fragment" experiment was set up primarily to try out the method and equipment for timely investigation of the Earth's natural resources from space. In addition, the information obtained is sent to numerous organizations in the Soviet Union and other socialist countries, where it is often used for practical purposes and is economically effective.

As an example, let us describe how the Institute of Cybernetics of the USSR Ministry of Agriculture made use in the Stavropol' Kray of the information which is obtained. After processing this information in the form of thematic maps and summaries, the Institute forwards it to local agricultural agencies. These, in turn, make effective use of it to observe the seedlings and the maturing of plantings, to single out the locations of diseases and to make crop predictions. According to the Institute of Cybernetics, the savings from using information from "Fragment" (in that region alone) amount to hundreds of thousands of rubles.

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KOSPAS-SARSAT SATELLITE RESCUE SYSTEM

Moscow PRAVDA in Russian 6 Aug 82 p 3

[Article by Yu. Zubarov and Yu. Makarov, USSR representatives, KOSPAS-SARSAT International Coordinating Group: "A Lifesaving Satellite in Orbit"]

> [Text] The "Cosmos-1383" artificial Earth satellite was launched in the Soviet Union on 30 June 1982. It carries equipment that will be used as part of a system for determining the location of ships and aircraft in distress. This equipment was created and launched into a near-Earth orbit in accordance with the plan for the realization of the international KOSPAS-SARSAT project, which has been developed jointly by specialists from the USSR, the United States, Canada and France. In addition to thoese countries, Norway and England have expressed a desire to participate in the upcoming tests to evaluate the system's effectiveness. Japan and a number of other countries are also considering the question of their effectiveness.

The development of the international KOSPAS-SARSAT project began in 1977. It required considerable efforts on the part of specialists from four countries in order to determine the principles of the joint system's structure, to coordinate its technical characteristics and to manufacture the appropriate space and scientific equipment. The unified system consists of two independent parts that, at the same time, are completely technically compatible: the Soviet KOSPAS system and the American-Canadian-French SARSAT system. Both parts were developed in parallel and coordinatedly. The interaction between the participating countries during the development and realization of the project was carried out through the KOSPAS-SARSAT International Coordinating Group, which consists of two representatives from each of the four countries.

The Soviet (KOSPAS) part of the system consists of emergency radiobuoys that are to be installed on ships and in airplanes and helicopters, radio equipment carried by spacecraft that will receive signals from the buoys, process them and transmit them to Earth, ground stations for the reception of information from satellites, and a national system control center. The SARSAT system has an analogous composition. Thus, each of the four countries participating in the KOSPAS-SARSAT project is building its own emergency radiobuoys, ground information reception stations and joint system centers. The satellites will be launched by the USSR and the United States. The planning and production of the on-board equipment for the American

satellite is being done by specialists from the three western countries, whereas for the Soviet satellite it is being done by our own industrial forces.

The system that is being created will utilize low-flying satellites launched into near-polar circular orbits at altitudes of 800-1,000 km. Because of this the system's coverage area will encompass the entire Earth, which will make it possible to search for vessels and aircraft in distress in any part of the world.

It has been suggested that two types of emergency radiobuoys be tested: new ones and ones that are already widely used, particularly in aviation. There are already more than 200,000 such buoys. They are intended to be used for search and rescue operations carried out with the help of aviation. However, their detection range and reliability are extremely limited. In the space system, therefore, there is a capability for working with both the existing and new emergency radiobuoys. The use of the existing radiobuoys will make it possible, even in the experimental stage, to use the system to receive distress signals sent out in case of a real emergency, it being the case that the coordinate determination accuracy will be 10-12 km.

The possibilities for using new buoys are considerably wider. When they are in use the accuracy of the determination of the coordinates of ships and aircraft in need of help will be several times better and will be in the 3-5 km range. In addition, the new buoy's signal will contain information that makes it possible to determine the type and name of the ship or aircraft in distress, its national affiliation, the nature of the problem and the time that has elapsed since the emergency began.

The future ground stations for the reception of emergency information from the satellites will be located in different parts of the world in order to accelerate the reception of distress signals. By the beginning of the tests, stations will be ready in Moscow, Toulouse (France), Ottawa (Canada) and St. Louis (United States). Additional stations will be built in the USSR in 1982-1983, in Arkhangel'sk and Vladivostok. The ground stations are equipped with parabolic antennas that track the satellites automatically, as well as radio-receiving and computer facilities for determining the coordinates of the place where the emergency is happening.

The emergency information will be sent from the ground stations to the national system centers so the type of emergency and the national affiliation of the vessel or aircraft in distress can be determined. After this, the information (including the data on the coordinates) will be sent to the country to which the ship or aircraft belongs and to the search and rescue service responsible for the area concerned. The Soviet KOSPAS system center has been set up in Moscow, as part of the Ministry of the Maritime Fleet.

As has already been reported in the press, the last meeting of the KOSPAS-SARSAT International Coordinating Group was held in Moscow in April of this year. At this meeting there was a comprehensive discussion of the path of the realization of the joint project, a discussion of the results of ground tests of the system's elements, and a confirmation of the overall readiness for the beginning of the tests. It was agreed that the tests would begin with the launch of the first Soviet spacecraft carrying KOSPAS system equipment, which would be joined by the American satellite early in 1983. Thus, the "Cosmos-1383" became the first satellite for the KOSPAS system. It was inserted into a circular, near-polar orbit at an altitude of approximately 1,000 km. Its period of revolution around the Earth is about 105 minutes.

During the time that has passed since the spacecraft was launched, all the elements of the system have been actively tested. These tests confirmed that the on-board and ground equipment created by Soviet industry functions normally. In Moscow, the KOSPAS System Center and the ground emergency information reception station went into operation. Training for interaction among the KOSPAS and SARSAT centers is being conducted on a regular basis.

For the purpose of conducting integrated tests of the system, experimental prototypes of emergency radiobuoys operating on a frequency of 406 MHz have been placed in different regions in the European part of this country. Several times a day the buoys' signals are received by "Cosmos-1383" and transmitted to the ground information reception station, where the coordinates of the buoys' locations are calculated. The first results of the tests confirmed the system's great potential possibilities: the accuracy of the determination of the buoys' locations is extremely high, with the errors not exceeding 1-2 km on the average.

In the second stage of the testing, the system's functioning will begin to be checked with buoys being used under full-scale operational conditions, in particular on ships sailing in different regions of the world from the Arctic to Antarctica. There will also be tests with free-floating buoys, which will make it possible to simulate the real conditions that arise when a ship or aircraft is lost at sea. In the near future, specialists from the United States, Canada, France, Norway and England will also begin to participate in the tests for the development of the joint KOSPAS-SARSAT satellite using the Soviet "Cosmos-1383" spacecraft.

With the launching of the "Cosmos-1383" satellite the Soviet Union has made yet another important contribution to international cooperation and has laid the foundation for the practical realization of the KOSPAS-SARSAT space system, which is being created for the benefit of all the world's peoples. It also again confirmed the possibility for successful international collaboration in the peaceful conquest of space.

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COMMUNICATION SATELLITE SYSTEMS

Moscow PRAVDA in Russian 3 May 82 p 3

[Article by G. Markelov and M. Fedorov, doctors of technical sciences: "Communication Via Orbit"]

[Text] Cosmonautics is having a huge effect on different areas of science and the national economy. However, its effect on information reception and transmission facilities is particularly profound. Communication links utilizing artificial Earth satellites have become a fundamentally new factor in this respect. A satellite receives radio signals from a ground station and retransmits them, with or without preliminary amplification, to another station. In connection with this, it is possible to operate simultaneously, through a single satellite, a considerable number of stations that are large distances apart.

A retransmitting satellite's orbit is selected with due consideration for the area that is to be serviced over a given period of time. A circular, geostationary orbit is particularly convenient. It is at an altitude of 36,000 kilometers and its plane coincides with that of the equator. The satellite is motionless relative to a terrestrial observer, and its radio visibility zone covers more than one-third the surface of our planet.

In recent years communication via artificial Earth satellites has occupied the leading position relative to other types of electric communication. In particular, this is explained by the fact that the links' traffic capacity and economic efficiency for the transmission of information over great distances are great, there has appeared the possibility of realizing global (worldwide) communication and so on.

The creation of a new retransmitting satellite is a great event. Since 1978, the family of "Molniya," "Raduga" and "Ekran" satellites has been supplemented in the Soviet Union by satellites in the "Gorizont" series.

A "Gorizont" geostationary satellite is a multipurpose tool. It is used for communications, broadcasting and control, and makes it possible to increase significantly the transmission of information in the interests of our country's national economy and international cooperation.

The "Gorizont" fulfills part of its "obligations" in combination with the network of "Orbita" ground stations, the capabilities of which have now been expanded considerably. It is now possible to relay two Central Television programs and allow for the

differences in local time throughout the country. In addition to television broadcasting, satellite communication channels are provided for radio broadcasting, telephonic communications and the transmission of newspaper matrices.

Signals are relayed to "Orbita" points through several broad-band "trunks" in a "Gorizont" satellite's transceiving equipment. Through each such "trunk" it is possible to transmit one television program or to realize simultaneously about 1,000 telephone conversations.

The "Gorizont" is increasing the amount of information in the "Intersputnik" system considerably. International telephone and telegraph communication and the exchange of television and radio programs among different countries have been organized.

The "Gorizont" satellites make it possible to enlarge the "Intersputnik" system's service zone. Through them it is possible for the capital of our Motherland to communicate with all the populated continents on the globe. The ranks of the "Intersputnik" organization have also been enlarge , having been joined recently by Afghanistan, Vietnam, Laos, the People's Democratic Republic of Yemen and Syria. More than 20 countries that are not members of the organization make use of its services. During the 1980 Olympics, more than 30 countries received about 2,000 hours of transmissions from Moscow via the "Gorizont" satellites.

"Gorizont" also interacts with the "Moscow" television system, in which comparatively cheap and simple ground reception stations are used. The "Moscow" and "Ekran" systems make it possible to receive television programs throughout the entire country.

The use of "Orbita" stations for these purposes alone is economically justified only for large population points. As far as the "Ekran" system is concerned, it is highly efficient and is operating successfully in the cities and villages of Siberia, the Far North and part of the Far East. However, in view of the limitations imposed by the possibility of interfering with the ground communication facilities of neighboring countries that operate on the same radio band, it is not possible to expand the "Ekran" system's operating zone to other parts of our country.

In order to operate with the "Moscow" system's stations, in the "Gorizont" satellite's on-board relay equipment there is a special "trunk" with increased power and a narrow-beam antenna. The power flux density that is achieved at the Earth's surface in connection with this makes it possible to receive simultaneous television signals with small antennas (with a dish diameter of 2.5 meters). Moreover, interference with ground services is eliminated because of the special signal procesing methods that are used.

In March 1982 a modernized version of the "Gorizont" satellite, which solves a number of additional satellite communication problems, was launched into orbit. In addition to a six-trunk transceiving unit for the "Orbita," "Intersputnik" and "Moscow" systems, it carries additional retransmitting units that have the international registration names of "Luch" and "Volna." They provide seagoing ships and airplanes with satellite communications. In particular, this will make it possible to improve the efficiency of merchant marine fleet control, reduce travel time, and increase the safety of navigation on the world ocean. Soviet industry has already begun producing the ship equipment for communication via the "Gorizont" satellite.

During the development process the creators of the satellite ran into a number of scientific and technical problems. For example, it turned out to be rather difficult to achieve electromagnetic compatibility among the different on-board relay equipment when functioning in different radio bands and to insure high reliability along with an extended service life.

The "Gorizont" utilizes the standardized designs for on-board systems and equipment used in the "Raduga" and "Ekran" satellites, with alterations based on the achievements of space technology in recent years.

The structural dynamics system of the "Gorizont" provides it with triaxial orientation in space with an accuracy of several angular minutes. The satellite's longitudinal axis is always directed toward the Earth.

On the end face of the instrument compartment, the axis of which coincides with the satellite's longitudinal axis, there is an antenna unit. It consists of waveguide channels and a set of antennas. By switching part of them it is possible to change the areas serviced by the individual retransmitting trunks.

Two panels of solar photoconverters are connected to the instrument compartment by uniaxial electric drives. The panels rotate around the satellite's transverse axes at a speed that is close to the orbital speed, which guarantees their permanent orientation on the Sun. At the same time, the drives are also used to send electricity from the panels to the on-board equipment.

The on-board retransmitting device is located, together with the command and measurement system's instruments, in a cylindrical compartment. Here also is a bank of chemical storage batteries that power the equipment in shaded sections of the orbit during the spring and fall.

The "Gorizont" is lifted into orbit by a multistage "Proton" launch vehicle having a "D" rocket unit as its last stage.

The creation of the multifunctional "Gorizont" retransmitting satellite is a large contribution to the fulfillment of the assignment made by the 26th CPSU Congress: "Make extensive use of Earth satellites for the organization of multiprogram television and radio broadcasting, telephone communication with remote regions and the transmission of central newspaper type pages by phototelegraphy." Soviet science and technology has again demonstrated how great the possibilities of space technology are in the service of human progress.

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GEOLOGICAL OBSERVATIONS BY 'SALYUT-7' COSMONAUTS

Moscow PRAVDA in Russian 10 Jun 82 p 6

[Article by A. Pokrovskiy, special correspondent: "A 'Field Season' in Orbit"]

[Text] The taiga has turned green and the mountain paths have dried out. Many prospecting parties are already on their way so that they can discover new underground "warehouses" for their country during the summer field season. But look to the sky, geologist: now there are two "heavenly geologists"--cosmonauts Anatoliy Berezovoy and Valentin Lebedev--who, along with you, are surveying for useful minerals from their remote path in space.

They, also, got ready for their "field season" ahead of time. However, what they put in their field rucksacks were not geological hammers, but precise instructions in the logbook, a set of images of the most characteristic geological structures, tape recordings about observation techniques and personal impressions. As they say, it is better to see something once than to hear about it a hundred times. This is why Berezovoy and Lebedev, along with their own geology teachers, took airplane trips before they were sent in orbit in order to observe the Crimea, the Caucasus, the characteristic folds in the oil-bearing regions near Baku, the young faults around Kopetdag, the Karakum Desert and the highest peaks of the Pamir Mountains, where it is as if the Earth's crust (in the words of the specialists) is turned inside out, which means that a study of this area will help us understand what is being created in the depths of our planet.

However, it goes without saying that the view from an airplane gives no idea of the scale of the picture seen from the altitude of a near-Earth orbit. The interest with which the specialists awaited the "El'brus" crew's first reports on the results of their observations is understandable.

"They literally overflowed with impressions," says V.V. Kozlov, chief geologist of the USSR Ministry of Geology's "Aerogeologiya" association. "And during the time allocated to us during the radio session, they tried to tell us as much as possible. There is now no doubt that the main crew of 'Salyut-7' will make significant additions to the information that was gathered from the preceding orbital stations."

What problems were Anatoliy Berezovoy and Valentin Lebedev faced with during the first stage of their geological observations? First of all, they were visually to detect new or confirm the existence of structures that were not clear in previously taken photographs. As is well known, the experience gained in spaceflight has

demonstrated that in a number of cases the human eye is a more reliable tool than the very best camera. The "El'brus" crew confirmed this once again.

In particular, they were to observe, on the left bank of the Volga, the boundaries of the so-called Astrakhan' arch, which is a gently sloping uplift of strata in the Earth's crust. There, as specified by decisions made at the 26th CPSU Congress, projects to exploit the gas-condensate deposit are being carried out. However, the matter is complicated by the fact that although on one bank of the Volga the arch's boundaries have been delineated clearly, on the other bank they are covered with sand. Anatoliy Berezovoy and Valentin Lebedev sent to Earth the message that they had succeeded in distinguishing the left-bank continuation of the arch and its boundary. Consequently, there is now an opportunity to make better plans for the ground geophysical work and the placement of wells. This promises a reduction in the amount of time required to survey the deposit.

Another new piece of information for the geologists was the "El'brus" crew's report that between the Caspian and Aral Seas they observed not the separate "little plates," or specific fine structures, that were previously assumed to be there, but a sequential chain of them. This aroused additional interest on the part of the geologists for prospecting work in this gas and oil region.

In all, the "El'brus" crew was given about 20 assignments having to do with visual observation. They are not only dealing with them successfully, but are overfulfilling their quotas. On their own initiative they discovered a lineament (a fracture zone) running in the latitudinal direction from the Caspian Sea to the Lake Balkhash area. It had not been plotted on geological maps previously, since it is difficult for both ground expeditions and aerial surveys to detect it because of the complex relief conditions in that area.

It should be said here that the geologists were among the first to find a common language with the cosmonauts. This alliance has proven to be extremely fruitful. By looking "from the sky to the ground," the cosmonauts were able to make a number of significant discoveries. For instance, they discovered previously unknown ring structures and lineaments on scales that can be seen only from orbital altitudes. The knowledge of these structures will help us determine the regularities in the location of useful minerals in the Earth's crust.

There have also been purely practical results. The view from space made it possible to examine the ancient volcanoes in the Okhotsk-Chukotsk volcanic belt. Volcanic pipes from deep magmatism that are covered by Siberia's taiga and swamps have been seen. Yet another zone containing tin ore has been found in the eastern part of the Yakutsk ASSR. Finally, maps that have received the name "cosmophotogeological" have been compiled. All of this, taken together, facilitates the better organization of searches for useful minerals and to place them at the service of the national economy more rapidly.

It is no accident that a young branch--space geology--has appeared in the family of Earth sciences during the years of the space era. A new subunit has been formed in the "Aerogeologiya" association: the Central Aerospace Geological Expedition. The cadres of specialists, for which Moscow State University has published the textbook "Space Geology," are also growing.

"Little by little, however, it is becoming outdated," noted V.V. Kozlov at the end of our conversation.

Could this also be an evaluation of the work being done by Anatoliy Berezovoy and Valentin Lebedev? This is the work being done in only one of the many branches of knowledge in the development of which cosmonautics is taking an active part.

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UDC 528.77:63+629.7:911

EXPERIMENT IN COMPARING IRRIGATED AGRICULTURAL LANDSCAPES IN DESERT ZONES, USING SPACE PHOTOGRAPHY MATERIALS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82 (manuscript received 21 May 81) pp 13-23

GLUSHKO, Ye. V. and KONDRAT'YEVA, T. I., Geography Department, Moscow State University imeni M. V. Lomonosov

[Abstract] After analyzing space photographs of key sections in the Golodnaya Steppe in order to determine the standard images for different soil and crop types encountered in subtropical deserts, the authors use these standard images in an attempt to interpret agricultural landscapes in the subtropical desert areas of Arizona, using the method of remote extrapolation. They describe in detail the photographs and zoning methods that were used, as well as the climatic and temperature conditions of both areas. After comparing the photographs and distinguishing 10 anthropogenic formations common to both, they conclude that interpretation by analogy is a valid method for determining land use in widely separated areas. Figures 5; references 16: 11 Russian, 5 Western. [109-11746]

UDC 551.451.8.629.78

EXPERIMENT IN EVALUATING DECIPHERABILITY OF STRUCTURAL-ZONAL PHOTOGRAPHS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82 (manuscript received 12 Jan 82) pp 34-42

KRAVTSOVA, V. I., Geography Department, Moscow State University imeni M. V. Lomonosov

[Abstract] Using green-zone aerial surveying photographs with a 1:56,000 scale that were taken with the MKF-6 camera, the author obtained structural-zonal photographs in 10 spectral bands ranging from 1-3 mm^{-1} to 40-45 mm^{-1}. The problem that was formulated was to determine the possibility of developing a method for evaluating forested land on the basis of these photographs. After describing the difficulties encountered (having to do largely with physical

characteristics of the photographs), the author describes the comparison that were made with materials from other sources and gives her reasons for concluding that spectral-zonal photographs can be useful in distinguishing forests with different assessment characteristics and in determining their quantitative characteristics, but only in conjunction with other remote sensing materials. Finally, she presents an example of the joint use of structural-zonal and multispectral photographs. Figures 5; references 3.
[109-11746]

UDC 528.77:550.814+629.78(571.1)

ERRORS IN GEOLOGICAL INTERPRETATION OF SPACE PHOTOGRAPHS OF WESTERN SIBERIA

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82
(manuscript received 16 Jan 81) pp 43-46

KUZIN, I. L., All-Union Petroleum Scientific Research Institute of Geological Exploration

[Abstract] The author attacks V. I. Astakhov's theory that much of the present geological structure of the upper levels of the sedimentary mantle of the Western Siberian platform is of glacial rather than tectonic origin. He states that Astakhov has formulated a theory on the basis of his own interpretation of space photographs, then assumed the theory to be true and used it to draw further conclusions, but that it is contradicted by geological surveying materials and does not agree with the conclusions reached by other investigators. He also accuses Astakhov of ignoring the opinions of investigators who do not believe as he does. References 11.
[109-11746]

UDC 528.77:550.814+629.78(571.1)

TECHNIQUE FOR GEOLOGICAL INTERPRETATION OF SPACE PHOTOGRAPHS OF REGIONS WITH PLATFORM COVER

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82
(manuscript received 4 Nov 81) pp 47-52

ASTAKHOV, V. I., Aerial Methods Laboratory, "Aerogeologiya" Geological Production Association, Leningrad

[Abstract] The author defends his hypothesis that much of the shallow geological structure of the Western Siberian platform is of glacial origin, but extends his use of the term "glacial" to mean the sheet of ice that covered that part of the USSR during the last Ice Age. He also defends the use of space photographs as valuable materials for determining hidden geological structure and the presence of gas and oil. References 10.
[109-11746]

UDC 631.4:629.78

DETERMINING DEGREE OF WEED INFESTATION OF CEREAL CROPS FROM SPECTRAL MEASUREMENT DATA

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82
(manuscript received 8 Apr 81) pp 59-68

KONDRAT'YEV, K. Ya. and FEDCHENKO, P. P., Main Geophysical Observatory imeni A. I. Voyeykov, Leningrad; and All-Union Scientific Research Institute of Agricultural Meteorology, State Committee for Hydrometeorology and Environmental Control, Obinsk

[Abstract] The authors attempt to formulate a method for determining the degree of weed infestation in cereal crop fields on the basis of the spectral reflectivity of the weedy vegetation. Three different periods are investigated: the preplanting period (for a field that has been tilled, but not recently), the ear formation period and the waxy ripeness period. Using data obtained during airborne and ground measurements of spectral brightness with a dispersion photometer, the authors obtain good results for winter rye 1.5-2 months before the harvest; the error factor for barley and oats is considerably higher and the confidence intervals of the coefficient of spectral brightness of wheat and weeds overlap during this period. In the period 3-4 weeks before the harvest, when grains have reached the waxy ripeness stage and are yellowish, while the weeds remain green, the spectral brightness coefficient contrasts are best of all. Figures 6; references 9.
[109-11746]

UDC 551.51:629.78+519.21:681.327

APPLICATION OF ELECTROMAGNETIC FIELD EQUATIONS TO DESCRIPTION OF INTERACTION OF RADIATION WITH NATURAL FORMATIONS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82
(manuscript received 8 Jun 81) pp 69-76

KOZODEROV, V. V., State Scientific Research Center for the Study of Natural Resources, Moscow

[Abstract] The author solves the problem of radiation diffraction in a statistically heterogeneous medium with randomly placed irregularities. He then analyzes the sensitivity of his solution to changes in a soil-vegetation system, using a model of the interaction of radiation with such a system for four different cases: homogeneous soil, the appearance of shoots, the appearance of leaves and homogeneous vegetative cover. As it turns out, the most important factors are the projective covering of soil with vegetation and the density of the vegetation. Figures 2; references 9: 8 Russian, 1 Western.
[109-11746]

UDC 579.21:681.327

MODEL OF FORMATION OF SPECTRAL IMAGES OF NATURAL OBJECTS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82 (manuscript received 7 May 80, after revision 7 Jul 81) pp 77-82

BYSTROV, P. V., GORODETSKIY, V. I. and CHAPURSKIY, L. I.

[Abstract] Recognizing the scarcity of original research materials for the question of the use of multispectral surveying data to identify natural formations by their spectral image (the vector of their coefficients of spectral brightness), the authors set up a mathematical model for the generation of such materials. After discussing the various factors the model must deal with (spectral brightness signal fluctuations on the Earth's surface and spectral brightness signal transformation in the atmosphere and the multispectral surveying equipment), they present a program for the computer realization of the model and compare the generated material with the results of an actual airborne survey. They conclude that the model is satisfactory for further use. Figures 2; references 9.
[109-11746]

UDC 551.51:629.78

STATISTICAL STRUCTURE OF ERRORS IN SATELLITE MEASUREMENT OF BRIGHTNESS TEMPERATURE OF EARTH'S INTRINSIC RADIO-FREQUENCY EMISSIONS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82 (manuscript received 12 Jun 81) pp 83-89

PETRENKO, B. Z., Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow

[Abstract] The author analyzes errors in measurements of the brightness temperature of the Earth's outgoing radiation that arise when absolute calibration of the measurements is done on the basis of two reference points. After setting up the mathematical apparatus for this analysis, he introduces a numerical example to evaluate the dispersions and covariations of measurement errors that are related to the use of external calibration. Finally, he concludes that calibration errors make a large contribution to the measurement errors and that the determination of the reference regions' radiation characteristics needs to be more accurate. Figures 5; references 6.
[109-11746]

UDC 629.783:778.39

EFFICIENT ORBITS FOR 'METEOR' ARTIFICIAL EARTH SATELLITES LAUNCHED TO INVESTIGATE EARTH'S NATURAL RESOURCES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82 (manuscript received 1 Apr 81) pp 90-94

ASTASHKIN, A. A., SAUL'SKIY, V. K. and USPENSKIY, G. R.

[Abstract] The authors discuss the problem of the proper orbits for artificial Earth satellites, launched for the purpose of investigating the Earth's natural resources, that carry equipment with viewing fields of different widths. They present a method for calculating such orbits, using as an example a "Meteor" satellite carrying instruments with viewing field widths ranging from 30 to 2,000 km. They conclude that the width of the viewing fields used is the most important factor in selecting orbital altitude and period. Figures 5; references 4.
[109-11746]

UDC 551.322:621.396.962.4

USING SHORT-WAVE PART OF MILLIMETER BAND FOR REMOTE SENSING OF DISTRIBUTION OF FRESH-WATER ICE ON WATER WITH RADIOTHERMAL EQUIPMENT

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82 (manuscript received 26 Aug 81) pp 95-98

MALYSHENKO, Yu. I., VAKSER, I. Kh. and LEVDA, A. S., Institute of Radio Physics and Electronics, Ukrainian SSR Academy of Sciences, Khar'kov

[Abstract] In an attempt to develop a new method for studying ice cover, the authors conducted an experiment that involved measuring the brightness temperatures of fresh water and fresh-water ice on a wavelength of 3 mm and comparing it with measurements on a wavelength of 8 mm that are available in the literature. Using data obtained with a two-channel radiometer under certical and horizontal polarization, they find that the latter polarization gives the best results for determining the presence of ice on water. They also find that as far as snow cover is concerned, wet snow has no effect on the accuracy of the determination, but dry snow alters the brightness temperature readings and results in lower accuracy. Figures 4; references 10: 5 Russian, 5 Western.
[109-11746]

UDC 502.3.330.115

REMOTE SENSING IN UNITED STATES GEOLOGICAL SERVICE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82 pp 103-105

IL'IN, A. V.

[Abstract] The author gives brief descriptions of the research projects reported on in the "United States Geological Survey Annual Report on Researches (1980)" that involve the use of data gathered with the help of satellites.
[109-11746]

UDC 061:502.3(528.77+629.78)(571.1/6)

AEROSPACE INVESTIGATIONS OF NATURAL RESOURCES IN EASTERN SIBERIA

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 82 pp 106-107

PLASTININ, L. A.

[Abstract] The Institute of Geography of Siberia and the Far East, which is subordinate to the USSR Academy of Sciences' Siberian Department, sponsored a scientific conference on the subject "Aerospace Investigations on Natural Resources in Eastern Siberia." The author lists the participants and the reports that were read. Date and place of conference not given.
[109-11746]

RESULTS OF UN SPACE CONFERENCE DISCUSSED

PM090943 Moscow IZVESTIYA in Russian 6 Sep 82 Morning Edition p 5

[Article by Prof Yu. Kolosov, doctor of juridical sciences: "Prospects for Space Cooperation"]

[Text] The second UN Conference on the Research and Use of Space for Peaceful Purposes held in Vienna 9 through 21 August ended with the unanimous adoption of a final report. This impressive document, elaborated jointly by delegations from 94 states, will soon be submitted for examination by the 27th UN General Assembly Session.

Like the entire course of the conference, the content of the report reflects the growing interest of the world's peoples in joint scientific space research and the utilization of the achievements of cosmonautics for practical purposes. The main characteristic of the conference was a recognition of the need to continue the conquest of space for the benefit of the whole of mankind.

The greetings message sent to the conference by L. I. Brezhnev, general secretary of the CPSU Central Committee and chairman of the USSR Supreme Soviet Presidium, was in tune with the mood of the overwhelming majority of the participants. The message noted that "cooperation in space must unite people and develop an understanding that we all live on the same planet and it is dependent on us all to ensure that the earth is peaceful and prosperous." The conquest of space creates additional preconditions for achieving this noble objective.

Used as relay facilities, communications satellites bring television screens to life in remote and inaccessible localities and make it possible to organize the simultaneous transmission of television programs in many countries of the world and even on different continents. This opportunity is provided today by two international space communications organizations--Intersputnik, which utilizes Soviet satellites, and Intersat, based on American equipment. Plans for the creation of new communications organizations of the same kind--the Arab states' Arabsat regional system, for example--were reported at the conference.

The time is approaching when domestic sets will be able to receive direct television programs broadcast with the aid of satellites. The preconditions

are being created for organizaing so-called direct international television broadcasting not requiring ground relay stations. This will undoubtedly lead to the broadening of international cultural exchange and the mutual enrichment of peoples and will promote better mutual understanding among them. However, the justice of the fears expressed at the conference by the representatives of various groups of countries concerning the possibility of abuses of this new medium of mass information should be acknowledged. It could be used by reactionary imperialist circles for hostile propaganda and interference in other states' internal affairs. This concern was reflected in the conference's final report, which talks about the need to observe states' sovereign rights in the process of implementing direct international television broadcasting.

Maritime communication and navigation satellites are already beginning to provide tangible savings in shipping and are considerably increasing safety at sea. Since 1982 they have been operating under the auspices of the Inmarsat international maritime satellite communication organization, which has around 40 members, including the Soviet Union.

Modern meteorology, hydrology, cartography, geology, forestry and so forth could no longer manage without data obtained with the aid of satellites relating to processes taking place on the earth and in its environment. The study of the earth from space--known as remote monitoring of the earth--has been placed at the service of many states. However, this type of space activity requires great attention to the interests of the sovereign peoples whose territories are studied from space. It is no coincidence that the conference report reflects indignation at the actions of the accomplices of the Israeli aggression in Lebanon, which included the use of space technology for observing the earth.

Despite the negative position adopted by the delegations from the United States and some of its allies, the conference expressed great concern at the growing danger of the spread of the arms race to space.

Shortly before the conference began the U.S. administration promulgated a directive on U.S. national space policy for the next decade in which it is possible to observe an unambiguous shift of priorities in favor of the military utilization of space and its transformation into a potential theater of military operations.

The Soviet delegation stressed the importance for the cause of peace of the proposal submitted by the USSR government at the 26th UN General Assembly session for the conclusion of an international treaty banning the deployment of weapons of any kind in space. As is known, a Soviet draft of such a treaty was submitted for examination by the Disarmament Committee, but to this day this body has not succeeded in embarking on the elaboration of such a treaty because of the opposition of the American representatives. The conference's demand that priority attention be devoted to the question of preventing the militarization of space is particularly urgent. It should be stressed that unity between the positions of the socialist and developing states emerged on this question.

The conference report speaks highly of the activity of various international organizations, primarily the United Nations, in the field of developing businesslike mutually advantageous cooperation between states in the practical application of the achievements of cosmonautics.

The World Space Forum took place on the eve of a historic jubilee--the 25th anniversary of the launch of the first artificial earth satellite by the Soviet Union. The fact that the first space power has always been and invariably remains a convinced supporter of the development of businesslike international cooperation in the field of the conquest of space for peaceful purposes for the benefit of the whole of mankind undoubtedly had an impact on the results of the conference's work. Living evidence of this was provided by the participation in the conference's work of cosmonauts from the fraternal socialist countries who have made flights aboard Soviet spacecraft and stations within the framework of the Intercosmos program. It was noted that the Soviet state effects space cooperation with many states irrespective of their sociopolitical systems and level of scientific, technical and economic development.

The conference confirmed that given good will and a spirit of cooperation states are capable of jointly solving the most complex and acute problems of the age.

CSO: 1866/150-F

KOTEL'NIKOV ON USSR-FRANCE COOPERATIVE SPACE PROGRAMS

Moscow IZVESTIYA in Russian 28 Jun 82 p 2

[Article by Academician V. Kotel'nikov, Chairman of the "Intercosmos" Council: "Orbits of Cooperation"]

[Text] Cooperation between the USSR and France in studying and conquering space is based on an inter-governmental agreement, signed in Moscow in 1966 during the visit of a French delegation headed by General De Gaulle.

The agreement provided for joint work in studying space, in the area of space meteorology, space communication via artificial Earth satellites as well as exchange of scientific information, post-graduate students and scientific delegations. Later, cooperation was extended to new areas: space biology and medicine, plus space material science.

The practical work of organizing joint space research was assigned to the "Intercosmos" Council, affiliated with the USSR Academy of Sciences and the French National Center for Space Research (CNES).

The joint Soviet-French research which has been conducted in space encompasses practically all areas of contemporary space science. In conducting this research, scientists from the two countries are utilizing various resources of rocket and space technology: lunar and inter-planetary automatic stations, artificial Earth satellites, manned orbital stations, research and meteorological rockets, high-altitude drift balloons and flying laboratories, as well as ground resources such as radiotelescopes, special cameras and other instruments.

Of all the diverse joint operations in space, I will dwell only on the achievements in three areas: in studying space and astro-physics, space biology and medicine, and space material science: I will dwell only on these areas since the scientific program of the Soviet-French interplanetary crew, working now on board the "Salyut-7" station, is a natural continuation and development of research in these specific areas.

The "Calypso" and "Jumeaux" cycles of experiments were devoted to the study of solar plasma at various distances from the Sun. The instruments for this research were installed on "Prognoz" satellites and the "Mars-6" and "Mars-7" automatic interplanetary stations. The results of these experiments provided valuable information about the dissemination of interplanetary shock waves, and their link with solar flares as well as information about the links between the characteristics of the interplanetary medium, the Sun's condition and magnetospheric phenomena.

French instruments for investigating the planets and interplanetary space were installed on the "Venera" and "Mars" automatic statio.s. With the aid of these instruments, the "Mars-5" and "Mars-7" stations determined the temperature of Mars' upper atmosphere, as well as the high-altitude distribution of concentrated atomic hydrogen in the vicinity of the planet. The "Venera-9" and "Venera-10" automatic stations determined the temperature in Venus' upper atmosphere and the relative content of hydrogen and deuterium.

The joint Soviet-French experiments in extra-atmospheric astronomy provided many new results.

The "Galactica" experiment was conducted in the field of ultra-violet astronomy; the equipment for this experiment was installed on the "Prognoz-6" and "Prognoz-7" satellites and was intended for the study of galactic sources of ultra-violet radiation. While the equipment was operating on these satellites, about 6,000 spectra, which were basically radiations from objects in the Milky Way, were received.

A number of projects were carried out in the areas of X-ray and gamma-ray astronomy. "Sneg-1", the first joint experiment in that direction, was conducted on the "Prognoz-2" satellite. An analysis of the experiment's results enabled Soviet and French scientists to show that observable solar phenomena are linked to the generation of line gamma-ray radiation which indicates that nuclear reactions occur on the Sun during solar flares. Based on the characteristics of gamma-ray radiation flares, the scientists succeeded in determining the chemical composition and density of the solar atmosphere in the area of the flares.

Subsequent experiments ("Sneg-2MP", "Smeg-2MZ" and "Sneg-3") in the area of X-ray and gamma-ray astronomy were conducted with the aim of detecting and localizing discrete cosmic sources of radiation. In the "Sneg" series of experiments, several scientific problems were solved: searching for X-ray and gamma-ray flares and localizing them; determining the provisional structure and energy spectrum of X-ray and gamma-ray flares; searching for discrete sources of radiation and classifying them; measuring the diffusion background of X-rays and gamma-rays.

In the March to May 1979 period, a cycle of ten experiments in space material science, under the general name "El'ma", was carried out on board the "Salyut-6" orbiting scientific station. The experiments were conducted on the Soviet electric heating units "Splav" and "Kristall".

The "El'ma" experiments were devoted to the study of crystallization of aluminum (with copper added) and tin (with lead added) under conditions of microgravitation. The experiments were also devoted to obtaining new magnetic materials; in this work, "neodymium-cobalt" was used, which can be obtained in principle under earth conditions, but its structure would be very heterogeneous; "mangenese-caesium", which cannot be obtained under earth conditions, was also used.

A subsequent group of "El'ma" experiments was devoted to studying crystallization from a gaseous state (vanadium oxides and germanium were used). Also studied was the influence of space flight factors on the crystallization of semiconductor materials from liquid state in samples of bismuth, tellurium and "bismuth-tellurium" and "indium-antimony" alloys. Finally, crystallization from "gallium-arsenic" and "gallium-indium-antimony" solutions was investigated in two "El'ma" experiments.

The first joint experiment in radiobiology was the "Bioblok" experiment, conducted on the Soviet "Cosmos-782" biological research satellite. The influence of cosmic radiation on several biological materials was studied in the experiment. The "Bioblok-2" experiment was conducted with an analagous purpose, on the "Cosmos-936" biological research satellite. In these experiments, the biological samples used were yeasts, Artemia salina eggs, tobacco seeds, lettuce seeds, etc. Evaluation of radiation danger from the influence of heavy nuclei of galactic cosmic radiation was continued on the "Cosmos-1129" biological research satellite.

The joint program in immunology consists of a study of the change in immunological potential during and after a space flight. Thus, in the "Ulysses" experiment, rats which had already been immunized, were used for this study on the "Cosmos-936" biological research satellite.

The "Cytos" experiment, carried out in January 1978 on the orbiting "Salyut-6" station, was devoted to research in cell biology. The purpose of this experiment was to study the influence of spaceflight factors on the kinetics of reproduction via division by one of the simplest organisms--the paramecium. The results of this experiment showed that spaceflight conditions stimulate reproduction via division among paramecii. Moreover, the number of cells on board the space vehicle was significantly greater than during a controlled experiment on earth.

Overall, Soviet-French cooperation in space research must be considered to be successfully developing in all areas of joint work. Also, the results which have been obtained during 15 years of cooperation have made an important contribution to an entire series of space science fields.

I am confident that the results of the space activities by the Soviet-French international crew will make a new contribution to the development of space travel.

9887
CSO: 1866/133

SAGDEYEV ON ACCOMPLISHMENTS OF 25 YEARS OF COSMONAUTICS

Moscow PRAVDA in Russian 4 Oct 82 p 3

[Article by Academician A. Sagdeyev, director, Institute of Space Research, USSR Academy of Sciences: "A Quarter of a Century With Satellites"]

> [Text] Twenty-five years separate us from the historic day of the launching of the first artificial Earth satellite. Its injection into orbit from a Soviet cosmodrome opened the space era for mankind. Since that time, in the span of a single generation an astonishing path has been covered at a headlong pace: there have been manned flights, landings on the Moon and flights of automatic stations to Venus and the other planets, and manned orbital stations with replaceable crews have been created.

Communication, navigation and geodesy, and weather service satellites have taken their places in near-Earth orbits. Numerous research satellites are expanding the boundaries of knowledge and we are preparing for the appearance of ever newer spacecraft "professions." Cosmonautics has become an important sphere of human activity.

The huge response related to the launching of the first artificial satellite in the USSR had technical, economic, social and even political consequences in the most diversified areas.

The first artificial Earth satellite--a modest (by today's standards) ball weighing a little more than 80 kilograms--was equipped with two radio transmitters operating in the meter band. Data on the propagation of radio signals from the satellite and the results of ground optical observations, amassed during the three months of its life as a heavenly body, became the first scientific information from space to be collected and processed by man.

Thanks to the support of the CPSU Central Committee and the Soviet government, scientists and specialists in our country were able to begin extensive and variegated investigations in space. Academicians S.P. Korolev and M.V. Keldysh played prominent roles in the development and realization of this program.

World cosmonautics has moved forward rapidly, passing through a number of generations of spacecraft that have replaced each other. More than 100 satellites are launched every year. Each of them is based on the results and the vast amount of experience of the last 25 years of tempestuous progress.

A modern spacecraft concentrates the achievements of different areas of science and technology. It is a very complicated system, capable of operating for several years under the conditions of the high vacuum encountered in space and large temperature gradients, that must insure the making of scientific measurements and maintain communication with ground centers. The "brain" of a spacecraft is its control system. The on-board complexes of modern satellites are so complicated that control over them can be insured only with the help of powerful computers with an operating speed of hundreds of thousands of operations per second. For all practical purposes, this amounts to a computer center in orbit. On-board computers, which are connected to the ground centers, have become part of a gigantic computer network on a planetary scale, and in the language of cybernetics, a satellite can be equated with an "intelligent remote terminal."

Continuing our imaginary journey through the compartments of a satellite, we encounter its "electric power station," or the electric power system that provides the current for the operation of its instruments and equipment. The most widely used electric power systems are based on solar photoelectric batteries. By converting the energy of sunlight into electricity, for the several years of a flight they provide the on-board electrical network with hundreds of watts, and even kilowatts in the case of large spacecraft. In several cases, energy sources utilizing radioactive isotopes are used in electric power systems. In order to insure communication at large distances from Earth, the on-board radio transmitter must emit a considerable amount of power. For instance, for a flight near Jupiter and Saturn, power consumption to maintain radio communication with Earth is in the hundreds of watts. Modern communication satellites that have been placed in a geostationary orbit (at an altitude of about 36,000 kilometers) relay several television channels and thousands of telephone conversations at the same time.

Or let us take the orientation system. It consists not only of various sensitive elements (optical orientation sensors, sensors of the angular velocities of the satellite itself, gyroscopes) and actuating elements (power gyroscopes or low-thrust reaction engines), but also a computer for processing data on the angular coordinates of stars and comparing them with the star catalog stored in its memory. This is a unique type of cybernetic navigator for a spacecraft.

Satellite scientific equipment complexes sometimes contain dozens of different instruments operating under an overall program. As far as their complexity and accuracy are concerned, these instruments are the equal of the measuring equipment used in the best scientific research laboratories. At the same time, high demands are made on these instruments for reliability (they must function flawlessly for several years) and stability under overloads and accelerations (for example, the instruments in the descent vehicles of the "Venera-9" and "Venera-14" series were subjected to 200-fold overloads).

The circle of national economic and scientific problems being solved with the help of rocket and space technology is expanding continuously: communications and television, geodesy and meteorology, navigation and rescue services, the study of natural resources, monitoring the state of the environment, material science and technology, medicine and biology, the study of the Earth's atmosphere and magnetosphere, solar physics and extra-atmospheric astronomy, flights to other bodies in the Solar System and so on.

Satellites are gradually becoming "specialized." For example, it is more convenient to place communication and meteorological satellites for global observation in a circular (geostationary) orbit, but in connection with this the "viewing angles" for the high latitudes are rather poor. In order to insure communication with these areas, satellites in severely elongated orbits with a large inclination are used. This, by the way, is how the Soviet "Molniya" communication system is organized. It is better to conduct experiments for the study of materials and space technology in a passively oriented satellite, without making any maneuvers that result in the appearance of additional accelerations that disrupt the desired conditions of weightlessness. Astronomical satellites, on the other hand, require active orientation, since their instruments must "look" at a given point in space for a long time. In gamma-ray astronomy, for example, the "exposure time" can reach several days.

These examples serve as an illustration of the fact that the space fleet is growing not only quantitatively, but also qualitatively, which also insures the conduct of research or technological operations in space under the most variegated conditions. It is clear that only countries with a powerful scientific, technical and economic potential are capable of creating such facilities.

The circle of national economic, scientific and other problems being solved with the help of space technology is quite broad. However, the demands being made on it cannot be satisfied without intensive development of the technical sciences, applied mechanics, the study of materials, physics and chemistry, computer technology and radio engineering, without the creation of new metallic and nonmetallic structural parts, without the development of highly efficient electric power sources and transformers and so forth. The solution of these problems required the enlistment of a large number of specialists from the most variegated branches of knowledge and industry.

One of the peculiarities of the scientific and technical revolution is that the efforts expended for the solution of any problem produce an additional, unexpected, indirect profit in addition to the planned effect. The development of space technology has produced many examples of this type.

Materials and elements created for extended operation under conditions of a high vacuum, large temperature gradients, the effect of ionizing radiation and huge pulsed overloads are used extensively in different branches of the national economy. By producing this type of inverse effect, space technology has had a huge economic effect and made a significant contribution to scientific and technical progress. However, even weightier results are expected in the near future when we succeed in finding ways for the mass production in space of materials and compounds with properties that are impossible to obtain under terrestrial conditions.

Cosmonautics has brought to life new and modern methods for organizing and controlling large projects. They are now also being used in areas that are far from space. When talking about the effect of the first satellite on a worldwide scale, we cannot fail to mention the waves it caused in reforming the system of higher education and the organization of science in different countries.

Having opened the space era, the Soviet Union was not only an example to the world that stimulated the extensive development of research in the use of space. It also laid the foundation for an broad front of joint international activity in space.

The internationalization of space research and the conquest of space found its expression in the "Intercosmos" program and the "Intersputnik" system. Scientists from the fraternal socialist countries were offered the opportunity not only to send their own instruments into space with the help of Soviet launch vehicles, but also to reap the fruits of the scientific and technical progress stimulated by cosmonautics. It is no accident that a number of items developed and produced in the CEMA member countries for the needs of cosmonautics are highly competitive in the world market.

The experience acquired in investigations with the help of automatic spacecraft in the "Intercosmos" program made it possible for citizens of the fraternal socialist countries to participate in flights of international crews. A Soviet-French expedition was realized last summer. Our Indian colleagues are preparing for a joint launch. Fruitful collaboration couples us with scientists and engineers from France, India, Sweden and Austria.

The scientific instruments on spacecraft launched as part of the "Intercosmos" program frequently bear the emblems of a number of countries. Working side by side, scientists, engineers and technicians speaking different languages find a common language in such a far from simple matter as putting together various complicated instruments and units. The combination of the efforts and experience of laboratories and institutes from different countries makes it possible to use the best that has been created in each collective and to develop space specialization (as is being done on large scales by cooperation within the framework of CEMA). A clear example of the internationalization of space research is the flight of a Soviet interplanetary spacecraft that is being prepared for a meeting with Halley's well-known comet. Scientists from nine nations are participating in the creation of the instruments for this project.

The practical fruits of cosmonautics can already be used and are being used not only by the developed, but also by the developing countries. Under the aegis of the United Nations, an entire system of international legal norms concerning the investigation and conquest of space has been set up. This is yet another confirmation of the effect of cosmonautics on the social sciences. Different international organizations for the coordination or realization of worldwide cooperation in space activities are being created. The scales of these activities are expanding rapidly. According to United Nations data, about 150 countries are using space communication services; more than 200 ground stations for the direct reception of cloud cover data and images from meteorological satellites (including the Soviet "Meteor" series) have been built in several dozen countries; more than 100 countries are using data from satellites to study natural resources; hundreds of vessels sailing the world ocean are equipped with facilities that enable them to find their positions extremely accurately with the help of navigational satellite signals. Our country is in favor of the further expansion of international cooperation in space. The Soviet Union and the achievements of its cosmonautics program are at the world's service for the progress of mankind.

The first few revolutions around the globe that were made by the first Soviet satellite changed our concept of man's capabilities and, having seen our planet from space as a small and still unique island of life and civilization, people understood and--even more strongly--sensed our responsibility for saving the world in our unique corner of the Universe.

11746

CSO: 1866/10

TWENTY-FIFTH ANNIVERSARY OF FIRST SATELLITE LAUNCHING

Moscow ZEMLYA I VSELENNAYA in Russian No 5, Sep-Oct 82 pp 4-10

[Article by Academician V. P. Glushko: "Twenty-Five Years of the Space Age"]

[Text] Unlimited vistas were opened up for man with the first steps beyond the confines of the earth into outer space. At the very inception of its development, astronautics has enriched us with efficient means for global study of our planet, planet-wide communications and television, navigation and weather services, verification of some international aggrements. Opportunities have been opened up for studying the Cosmos over the entire electromagnetic spectrum. Heavenly bodies have become accessible to direct study by unmanned probes and by man himself.

Astronautics has enabled man to become the real master of his planet. The possibilities that have opened up for conquest of outer space and the heavenly bodies to be found there, utilization of the energy of space, have given man confidence in his future. Problems that disturb mankind -- demographic, questions of energy and raw materials, and finally, the problems of preserving out planet and its civilization -- are finding a logical and fundamental solution.

Only a quarter of a century has passed since the triumphant day of the beginning of the space age, when the nation building communism launched into orbit the first artificial earth satellite made by the hands of the Soviet people. And yet astronautics has already won an honored place in science, technology, culture and art. Its precepts gain in breadth and depth with every passing year.

Following the USSR (4 October 1957), the United States was the next into space (1 February 1958) with the launching of Explorer-1; the third space nation was France (26 October 1965) with its satellite the Asterix-1; fourth was Japan (11 January 1970) with launching of the Osumi satellite; fifth was China (24 April 1970) with the Dongfang Hong. The sixth nation was the United Kingdom (28 October 1971) with launching of the Prospero, and the seventh was India (18 July 1980) with a satellite named Rohini. These nations put their satellites into orbit with launch vehicles that they had developed themselves. Several other nations are carrying out national space programs, and some of them have plans to develop their own launch vehicles.

The only interplanetary probes have been carried into orbit by launch vehicles of the Soviet Union, and then of the United States. Launch vehicles of these nations have placed in geocentric orbits satellites made by Canada, the United Kingdom, France, West Germany, Italy, Japan, Czechoslovakia, Australia, India, the Netherlands, Spain, the European Space Agency and other nations. International cooperation is intensely developing in the investigation and peaceful use of outer space. By 15 June 1982, a total of 107 astronauts from eleven nations had taken part in 84 space missions: 51 from the USSR, 47 from the United States, and one each from nine socialist nations (on Soviet spacecraft and orbital stations)--Czechoslovakia, Poland, East Germany, Bulgaria, Hungary, Vietnam, Cuba, Mongolia and Rumania. Preparing for missions on Soviet spacecraft are astronauts from France* and India, and for flights on U. S. spacecraft--from the Netherlands, Switzerland and West Germany. The duration of spaceflights has been extended to 185 days in the Soviet Union and 84 days in the United States. Soviet astronauts V. V. Ryumin, V. A. Lyakhov and L. I. Popov have made flights of six months duration, and V. V. Ryumin has been on two missions totaling an entire year in space. In the Soviet Union, 25 Soviet astronauts and 9 from other socialist nations have each been on one mission, 16 astronauts have made two spaceflights, 9 astronauts have made three flights each, and one has made four missions. The USSR has made a total of 50 spaceflights. As of now, the United States has made 34 spaceflights of which 29 astronauts have completed one mission, 11 have made two flights, 3 astronauts have made three missions each, 3 have made four flights each, and one astronaut has completed five missions.

The total duration of manned spaceflights as of 15 June 1982 on Soviet spacecraft and orbital stations was 2201 man-days, and on U. S. vehicles--962 man-days.

There has been considerable development of unmanned spaceflights to study the moon, planets and their satellites, the sun and miscellaneous celestial objects, sending valuable scientific information to the earth. The USSR has placed the most emphasis on using automatic probes to study the moon. Soviet work on the moon--lunokhods (moon crawlers), soil samplers that have returned moon rocks to the earth--has considerably enriched science. The United States has successfully completed three flights around the moon, and has placed astronauts on the lunar surface in six missions. Thus various regions of the moon have been studied by unmanned probes and by man himself.

Considerable progress has been made in development and production of permanent manned orbital stations circling the earth. The USSR is placing the greatest emphasis on this main road of man into space. Ths first such station, the Salyut, was launched in 1971 and was in operation for about six months. The Salyut-3 operated in space for a similar period, and the improved Salyut-4 space station completed a flight mission of more than two years. The Salyut-6 station of the new generation has been "at work" since 1977, and its mission has lasted nearly five years. And it has remained operable for all this time. This station has acquired a new character by incorporating two docking units

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*The Soviet-French flight has already been completed. See page 3 in this issue of ZEMLYA I VSELENNAYA. -- Ed.

for receiving manned and cargo spacecraft, and by the use of an automatic system for refueling in space.

Crew change on the Salyut-6 station by Soyuz two-man spacecraft and improved Soyuz T three-man ships, the use of Progress unmanned cargo craft for delivery of instruments, equipment and consumables to the station as required, replenishing fuel, water, air, delivering parcels, newspapers, letters--all this has made the station truly permanent and capable of carrying out a flexible program of extensive research and experiments.

The crew of the Soyuz—Salyut-6—Soyuz orbital complex at times was made up of four men. The capability of on-board preventive maintenance and repair with replacement of the devices and subassemblies of on-board systems in case of necessity by others sent up on the Progress cargo ship has improved the livability and extended the service life of the station so much that the creation of permanent continuously operating orbital stations has become a real possibility. The provision of an airlock for emergence of astronauts into open space has enabled necessary repair work as well as research work outside the Salyut-6 station. Thus the foundations have been laid for thorough investigation and industrialization of space, and for future colonization.

On 19 April 1982, the improved Salyut-7 station was put into orbit around the earth as the basis of the Soyus—Salyut-7—Progress complex operating with a new crew of astronauts.

For harmonious and long-range development of astronautics, we need to successively extend the duration of manned missions on the orbital station. This should be accompanied by continued investigation of the influence of all spaceflight factors on functions of the human organism, and by the development of scientifically sound necessary means of protection. An enormous amount of work remains to be done on developing first semiclosed and later entirely closed life support systems on spacecraft and orbital stations.

The use of manned and unmanned earth satellites (spacecraft and orbital stations) in the interests of science and the national economy has taken on a most variegated nature. In the first instance it has enabled world-wide observation with various degrees of resolution over any sections of our planet, its continents and seas. It has become possible to make global and regional maps for efficient land utilization, keeping track of crop growing, evaluating the anticipated yield of crops, determining regions attacked by pests, determining the salinity and moisture content of soils. In forestry a watch is being kept on timber cutting and reforestation, sections are being determined that have been struck by pests, forest fires are being detected in the early stages. From outer space we can observe seasonal flooding and abatement of rivers, forewarning of natural disasters. Observations of ice give valuable information on the navigational situation. Systematic continuous observations of the state of the atmosphere and underlying surface of the entire planet have provided an intense complex flow of information for operation of weather services. Global navigation via satellite improves the quality and reliability of shipping and airline service.

The search for natural mineral resources of the earth by satellite systems has become exceptionally important. Such systems have unique capabilities for high-altitude detection of structures on the surface of the planet that are typical of valuable rock deposits and oil-bearing regions.

New sciences have come into being -- space geography, space geology, space geophysics and so on. Cartography of the whole surface of the planet, geophysical and geological studies of the earth from space have enriched science and engineering to an extraordinary degree.

In addition to the diverse facilities for studying and using natural resources of the earth, providing its population with global means of communication, navigation and weather services, satellite methods also enable monitoring of the degree of pollution of the planet and the effectiveness of means used to protect its biosphere. Among the radical measures for protecting the earth from contamination, depletion and overheating is putting major industry and energy facilities beyond its confines in outer space. In the first instance, industrial production should be organized in space that makes use of unique properties such as weightlessness, clean vacuum, low temperature and solar energy, and production of unique materials that would be impossible or unprofitable to organize under terrestrial conditions. This pertains primarily to the manufacture of crystalline, optical and semiconductor materials, and some medicines. The investigation and development of such technological processes, research on space materials science, make up a considerable part of the programs carried out on spacecraft.

At the same time, processes are being worked out under space conditions for soldering, welding, melting, assembly installation, applying coatings; automatic machines are being designed that are capable of constructing standard components of large-scale structures. These are but the first steps on the road to the inevitable industrialization of space.

Amazing things have been done with the use of space vehicles for studying the universe. Astronomical and astrophysical spacecraft studies of the solar system and of celestial bodies beyond its limits have given unusual enrichment of science, answering many of the most interesting questions, and raising new ones, which is typical of investigation of the infinite.

Unmanned interplanetary probes of the Soviet Union and the United States have given us closeup photographs of most of the planets and satellites of the solar system, transmitting detailed panoramas to the earth from Venus, the moon, Mars. Pioneer-10 is now midway between the orbits of Uranus and Neptune, maintaining radio communication with the earth from a distance of nearly 4 billion km.

Another indication of the scale of development of astronautics is the number of manned and unmanned vehicles that have been launched into space trajectories. Up to the end of 1981, more than 2500 objects had been launched into earth orbits, and more than 130 -- into interplanetary orbits. At present there are about 50 communications satellites in geostationary orbits over the equator.

In the Soviet Union alone, as of 15 June 1982, 1732 vehicles had been placed in geocentric orbits with a total mass of 5,204 metric tons, or 10,344 metric tons with consideration of the final stages of the launch vehicles that went into the same orbits; 54 vehicles with mass of 171 metric tons (250 metric tons with consideration of the final stages) have made flights to the moon, Venus and Mars, been landed there, and gone into orbits of satellites of these celestial bodies and the sun.

At the end of 1981, there were 4743 objects of artificial origin in spaceflight. By this same data, 8251 objects had left orbit. These figures include space vehicles (satellites, stations, probes) and pieces of the last stages of launch vehicles, fairings, connectors, separated stages. At the beginning of 1982 there were 621 Soviet satellites with 1143 fragments in geocentric orbits, 426 U. S. satellites with 2284 fragments, 10 French satellites with 22 fragments, 21 Japanese with 22 fragments and many others. At the same time there were 59 spacecraft and 54 fragments in orbits around the moon, planets and sun.

The time is not far off when in addition to the acute problem of dealing with contamination of our planet, we will be faced with the problem of dealing with contamination of near-earth space. The problem of satellite saturation of the geostationary orbit has already come up.

The twenty-fifth anniversary of the space age has coincided with the 125-th birthday of K. E. Tsiolkovskiy, the founder of astronautics. Coordinated with both these dates is a new, considerably enlarged edition of "Astronautics" by Sovetskaya entsiklopediya.* The preceding second edition of the small encyclopedia "Astronautics" was compiled more than ten years ago. The intervening rapid development of astronautics has necessitated considerable expansion of the encyclopedia, inclusion of major events in this field of human endeavor up to 1982. The encylopedia published in 1970 included 1445 articles, and there will about 2500 in the new one. The index of the encyclopedia consists of the general heading "astronautics", including biographies, and also divisions "rockets and spacecraft", "rocket engines", "motion control in space navigation", "spaceflight dynamics", "automated systems and complexes for spacecraft control", "spaceports", "space communications", "space medicine and biology", "life support", "geophysics", "astronomy", "space law", "international cooperation".

Enlisted in compiling the new edition were scientists, designers, testers, those that take a direct part in making and using space-rocket facilities. They are the principal authors of the articles in the encyclopedia.

The birth and development of the idea of flight in outer space has an intriguing history. We know that even in ancient times the ideas of human flight in outer space and to celestial bodies had their inception and were developed to some extent. There are many legends, fantasies and science fiction stories devoted to interplanetary flight. Some authors were prophetic, and others

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*"Kosmonavtika" [Astronautics], V. P. Glushko, ed., Moscow, Sovetskaya entsiklopediya, 1982.

played a major role in spreading this idea, catching the imagination of young readers, many of whom were later to be pioneers in rocketry and space engineering. We will leave to one side the initial stage of development of the idea of man's flight in the celestial expanse dating from deep antiquity when these flights were made in fantasy by mystical powers. And much later, imagined flight was accomplished by magical means, fantastic animals, birds, horses, artificial wings, hurricanes and volcanic eruptions.

The millenia passed, and about 330 years ago and more recently, fantasy literature began to include descriptions of human flights to celestial bodies by using various forms of energy, machines and devices: an airship filled with an unusually light gas, steam engine, cannons, powerful magnets, springs, centrifugal machines, as well as concentrated mental energy emitted by the human brain, gravity screens, "negative" matter repelled by the earth, bodies transparent to a gravitational field, pressure of sunlight reflected onto the ship by a huge screen installed on a celestial body and many other devices. During this time, compositions appear that describe imaginary human flight by using sequentially firing gunpowder rockets (Cyrano de Bergerac "États et empires de la Lune", 1649), by rocket attachments using water as the reaction mass (Achilles Herault "Voyage to Venus", 1865), in a cannonball equipped with a rocket engine for correcting the trajectory and deceleration upon landing (Jules Verne "De la Terre à la Lune", 1870), on an artificial earth satellite used for navigational support (E. E. Hale "Brick Moon", 1869-1870). The idea of making artificial earth satellites by using rockets shot from a cannon is set forth by Jules Verne in "Five Hundred Million Begums" (1879). Finally, the novelist's fantasy uses a jet engine operating on nuclear energy for a flight to Mars (A. Bogdanov "Red Star", 1908) and a similar uranium engine for a flight to the moon (A. Tren and R. Wood "Second Moon", 1917). In another novel, a voyage to the moon was accomplished by using pressure of solar radiation on a large screen mounted on a spaceship (B. Krasnogorskiy "On the Waves of the Ether", 1913).

After publications of papers by K. E. Tsiolkovskiy, R. Goddard, R. Eno-Peltry, G. Aubert and other pioneer scientists in astronautics, fantasy writers were contrained to limit themselves mainly to rocket engines: solid-fuel, liquid-fuel, or using solar, electrical, fission, fusion or matter-antimatter energy, and for short-range flights--the pressure of sunlight, i. e. whatever science permitted. However, the human mind could not be content with energy limitations when the subject matter was interstellar and intergalactic journeys.

And what about the maximally attainable speed of light postulated by the theory of relativity? Even with the command of unlimited energy moving at such a velocity we will not be able to make flights beyond the nearest stars, not to mention flights within our own galaxy, much less flights between galaxies.

No one doubts the validity of Einstein's laws, just as earlier they did not doubt Newton's laws. But the thought arises that if Newton's laws have limits of applicability, might not the same be true of Einstein's laws? There ought to be a more general theory that embraces Einstein's laws as well, with Newton's laws that are part of Einstein's laws as a special case. And fantasy writers

are finding the way out of the situation by making hypothetical flights to all corners of the universe with the use of spatial multidimensionality, thus circumventing the prohibitions of relativity theory. Of course, enormous energy expenditures are required, but the Cosmos itself can serve as the source of energy.

The time paradox predicted by relativity theory is not the best way out of the situation. Not many would relish a return to the homeland with research results obtained at high cost, but worthless for being out of date.

Let's be fair: the purpose of science fiction is not to describe the facilities for making long spaceflights. Mostly they are adventure stories that sometimes bring up problems of astronautics. But in the best works of this genre the authors try to look at the distant, and sometimes not so distant, future to understand what it will be like, this society of the future, to evaluate the influence that the further development of astronautics will have on society and mankind, to examine various aspects of contact with an extraterrestrial civilization. Eminent works in such an intriguing genre of literature have been written by K. E. Tsiolkovskiy ("Outside of Earth", 1918-1920), S. Lem ("Astronauts", 1951; "The Magellanic Cloud", 1955 and others); I. A. Yefremov ("The Andromeda Nebula", 1957 and others); A. C. Clarke ("A Space Odyssey: 2001", 1971; "Meeting With Rama", 1975 and others), I. Asimov, A. and B. Strugatskiy... Too many to count!

A lot that has been predicted by science fiction has now become reality. But just as before the flight of fantasists outstrips the actual course of events, and in exciting our imagination draws us toward the the mysterious future.

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LAUNCH TABLE

LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS in English or Russian various dates

[Summary]

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
16 Sep 82	Ekran	35,580 km	--	23 hrs 46 min	0.3°
		(Near-stationary circular orbit; TV satellite with relay equipment for transmission of Central Television programs in the decimeter waveband; international registration index: "Statsionar-T")			
22 Sep 82	Cosmos-1409	39,340 km	613 km	11 hrs 49 min	62.8°
25 Sep 82	Cosmos-1410	1,522 km	1,500 km	116 min	82.6°
30 Sep 82	Cosmos-1411	384 km	208 km	90.1 min	72.9°
2 Oct 82	Cosmos-1412	280 km	255 km	89.6 min	65°
12 Oct 82	Cosmos-1413, -1414, -1415	19,000 km	--	11 hrs 13 min	64.8°
		(Near-circular orbit; 3 satellites launched by single booster; intended to improve components and equipment of a space navigation system being developed to locate civil aviation planes and merchant marine and fishing vessels of the USSR)			
14 Oct 82	Cosmos-1416	380 km	217 km	90.2 min	70.4°
19 Oct 82	Cosmos-1417	1,023 km	978 km	104.9 min	83°

Date	Designation	Orbital Parameters			
		Apogee	Perigee	Period	Inclination
20 Oct 82	Gorizont	35,800 km	--	23 hrs 57 min	0.8°
		(Communications satellite with improved multichannel relay equipment for telephone, telegraph, radio and TV; carries a 3-axis orientation system for solar batteries, telemetry systems and orbital correction system; near-stationary circular orbit)			
21 Oct 82	Cosmos-1418	417 km	362 km	92.2 min	50.7°
2 Nov 82	Cosmos-1419	290 km	216 km	89.3 min	70.4°
11 Nov 82	Cosmos-1420	820 km	782 km	100.8 min	74°

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7 Feb 83 [illegible]